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COVID-19 Cases and Factors Associated with 11 Indonesian Provinces, 2021

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ABSTRACT

In collaboration with other stakeholders, National Task Force of COVID-19 Control conducted massive detection of the cases, followed by contact tracing. The study aimed to overview COVID-19 cases from 58 districts of 11 provinces in Indonesia and its associated factors. A cross-sectional study design used secondary data from The National Task Force of COVID-19 Control. COVID-19 cases and other variables were collected in 58 districts in 11 provinces of Indonesia year 2021. The study incorporated descriptive, correlation, and multiple linear regression analysis with the district as an analysis unit. The median of COVID-19 cases was 804 per district, traced cases were 70.6% of cases, cases had contact was 2.6% of cases, close contact was 2,188, the ratio of close contact: cases were 2.75, isolation drop out was 8, quarantine drop out was 9, test for close contact was 962, COVID-19 vaccine dose 1 was 147, dose 2 was 205, and no vaccine was 354. Factors significantly correlated with COVID-19 cases were cases traced, cases have epicontact, close contact, and ratio close contact. In multivariate analysis, the percentage of traced cases, cases had epicontact, isolation drop out, COVID-19 vaccine dose-1, and no COVID-19 vaccine associated with COVID-19 cases. Identifying factors related to the incidence of COVID-19 can be used to increase efforts to prevent and control COVID-19 cases in the community as a response to alertness to the emergence of new cases due to new variation mutations.

INTRODUCTION

Coronavirus Disease-19 (COVID-19) is still transmitted in Indonesia since it declared as public health emergency in 2020. By 24 July 2022, there were 6,168,342 cases and 156,902 deaths (Case Fatality Rate/CFR 2.54%), and in the last week, the positivity rate was 9.1%.[1] To prevent and control COVID-19 spread, the Government of Indonesia established the National Task Force of COVID-19 Prevention and Control, stated in Presidential Decree No. 7/2020. The task force had function of coordinating the efforts of COVID-19 prevention and control among all stakeholders.[2]

The Ministry of Health has also issued guidance for COVID-19 prevention and control based on the WHO Interim guideline. The prevention and control including promotion and risk communication, vaccination, case detection, epidemiological investigation, contact tracing, isolation and quarantine, and treatment.[3] These efforts involved the health sector and other sectors, including army, police, and Ministry of Internal Affairs. There are several key efforts to prevent and control the transmission of COVID-19, including contact tracing management. This effort followed by monitoring, quarantine/isolation, and investigation.[4]

The National Task Force of COVID-19 Control, in collaboration with other stakeholders, conducted massive detection of the cases followed by contact tracing. In 2021, these activities were conducted in 58 districts of 11 provinces in Indonesia, namely Jakarta, East Java, West Java, Central Java, Jogjakarta, Banten, Bali, North Sumatera, Jambi, South Kalimantan, and Papua. The tracing was involved Village Post of COVID-19 control which incorporated 1,383 villages and 2,119 tracers. These activities could reduce the number of cases in 5 months from August to December 2021.

Based on the massive tracing, there were several lessons learned that can be taken to understand what determinants are associated with COVID-19 cases. In line with indicators of COVID-19 control, several factors may contribute to the cases, such as cases that can be traced for close contact, case with epicontact, close contact, quarantine, isolation, and vaccination.[3,5] These association may be used as a source of information to develop appropriate program to decrease COVID-19 cases in the future. As an emerging disease, information regarding an overview of COVID-19 instances is vital to know in order to create suitable preventative and control methods for related diseases.

Several studies revealed that tracing could reduce COVID-19 but not halt it under slower, less effective tracing conditions.[6] A study in the US, COVID-19 is disseminated by close contact and communal exposure.[7] The transmission dynamics close contacts are at an increased risk of getting the COVID-19 infection in the household.[8] Another study showed quarantine interventions can help limit the spread of COVID-19, likely to stop outbreaks in the general population.[9] Meanwhile, a study US showed that vaccination is substantially effective in reducing the risk of COVID-19.[10–16]

There is limited research on COVID-19 cases using a big number of cases as well as limited understanding of factors associated with COVID-19 in Indonesia. Thus, we conducted this study to overview COVID-19 cases from 58 districts of 11 provinces in Indonesia and its associated factors.

MATERIAL AND METHOD

This was a cross-sectional study conducted in March - July 2022. Population of the study was all COVID-19 cases in August-December 2021 from 58 districts of 11 provinces in Indonesia recorded in National Task Force of COVID-19 Control. A total of 103,399 became sample of the study which had completed data for all variables (total sampling). The study used secondary data from National Task Force of COVID-19 Control. Variables included in the study were dependent variable (COVID-19 cases) and 12 independent variables which consisted of traced cases, percentage of traced cases, cases have epicontact, percentage of cases have epicontact, close contact, ratio close contact: cases, isolation dropout, quarantine drop out, testing for close contact, COVID-19 vaccine dose 1, COVID-19 vaccine dose 2, and no COVID-19 vaccine.

This study involved descriptive, correlation, and multiple linear regression analysis. Multiple Linear regression was performed through bivariate selection, multivariate modelling, and the development of final model.[17] Final model had complied with all assumptions of multiple linear regression namely existence, independence, linearity, homoscedasticity, normality,

and collinearity.[17,18] The steps of the study consisted of preparation, data collection, data analysis, and paper writing.

RESULTS

COVID-19 cases gradually decreased from 26,080 in week 32 to be 78 cases in week 53 (August – December 2021). A total of 103,399 cases was reported in this period (Figure 1). The biggest cases of this study were 18,608 (18.00%), in Bali province, and the lowest was in Papua, for 292 cases (0,28%) (Table 1).

Figure 2 shows the distribution of cases by district which the highest number was in Bantul regency, Jogjakarta (9171 cases) and the lowest in Rembang Regency, Central java (23 cases).

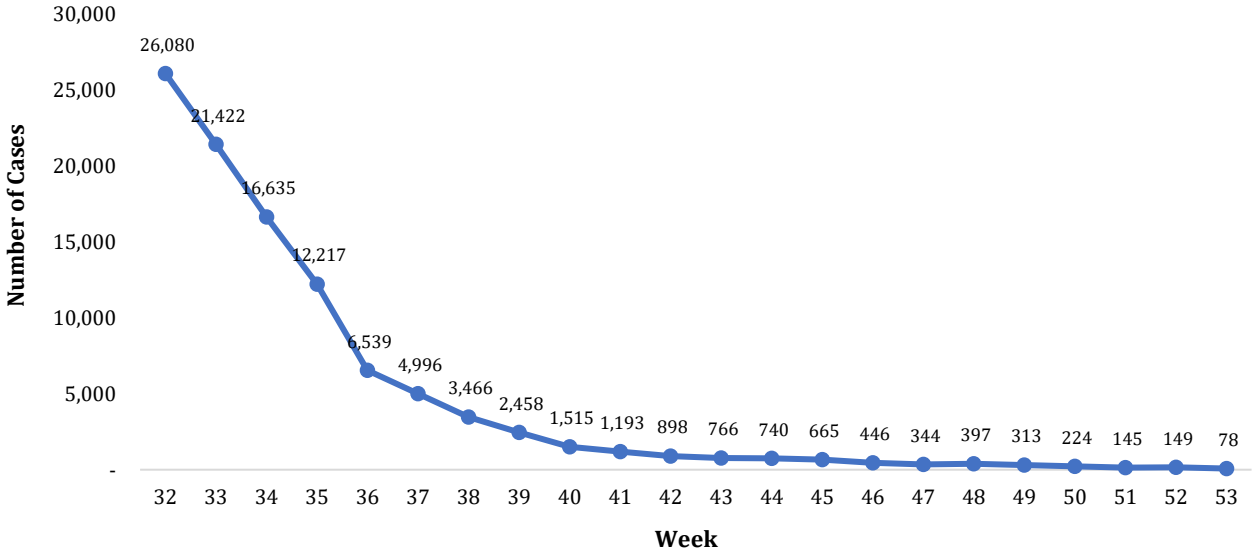
Average (median) of COVID-19 cases was 804 per district, cases traced close contact was 504 or 70.61% from cases, cases had epicontact was 210 or 32.63%, close contact was 2,188, ratio close contact: cases was 2.75, isolation drop out was 8, quarantine drop out was 9, test for close contact was 962, COVID-19 vaccine dose 1 was 147, dose 2 was 205, and no vaccine was 354 (Table 2).

Table 3 shows factors that significantly associated with COVID-19 cases in bivariate analysis were cases traced, cases have epicontact, close contact, ratio close contact: cases, isolation drop out, quarantine drop out, testing for close, vaccine dose-1, vaccine dose-2, no vaccine. Meanwhile, percentage of cases traced close contact and percentage of cases with epicontact were not associated with COVID-19 cases.

Table 1. Distribution of Covid-19 Cases by Province

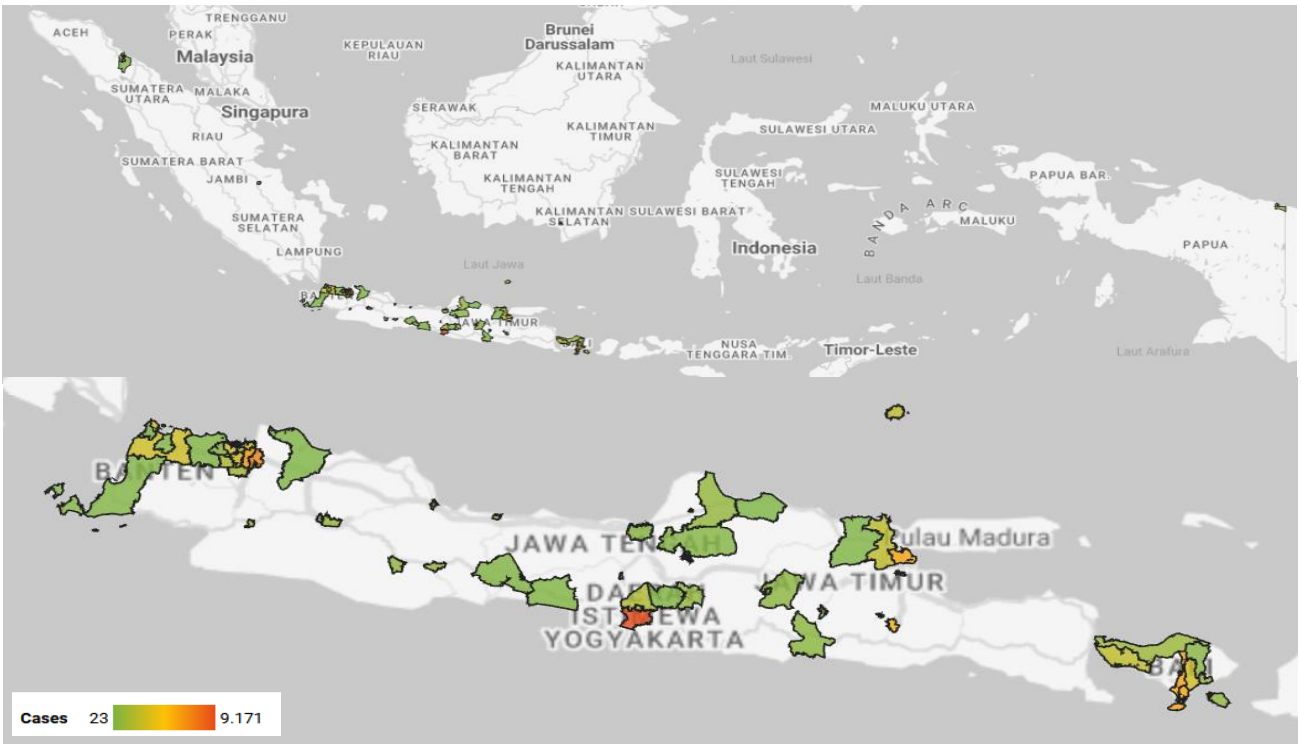
Province	Number of District Selected n = 58	Number of Cases n = 103,399	Cases (%)
North Sumatera	2	9,161	8.86
Jambi	1	3,373	3.26
Banten	7	5,625	5.44
Jakarta	5	15,756	15.24
West Java	8	12,284	11.88
Central Java	12	3,578	3.46
Jogjakarta	3	12,545	12.13
East Java	10	17,216	16.65
Bali	7	18,608	18.00
South Kalimantan	2	4,961	4.80
Papua	1	292	0.28

Source: National Task Force of COVID-19 Control, 2021



Source: National Task Force of COVID-19 Control, 2021

Figure 1. Covid-19 Cases in 58 Districts of 11 Provinces in Indonesia, Week 32-53 2021



Note: Indicates Smaller Number of Cases Means Bigger Number of Cases

Source: National Task Force of COVID-19 Control, 2021

Figure 2. Distribution of COVID-19 Cases by Districts

Table 2. Distribution of Covid-19 Cases and Selected Factors in 58 Districts, 2021

Variable	Median	Min	Max	SD	Range	Sum
Covid-19 Cases	804	23	9,171	2,262	9148	103,399
Traced Cases	504	24	9,057	1,733	9033	71,915
% Traced Cases	70.61	3.6	100	40.9	-	-
Cases Have Epicontact	210	4	3,949	865	3945	34,432
% Cases Have Epicontact	32.63	2.16	100	23.1	-	-
Close Contact	2,188	79	44,417	7,482	44,338	294,819
Ratio Close Contact: Cases	2.75	0	16.6	3.18	16.6	-
Isolation Drop Out	8.5	0	1,332	219	1332	4383
Quarantine Drop Out	9.0	0	1,787	344	1787	8028
Testing For Close Contact	962	0	25,412	3,667	25,412	117,142
COVID-19 Vaccine Dose 1	148	0	4,124	1,102	4124	39,722
COVID-19 Vaccine Dose 2	206	0	4,759	1,133	4759	40,747
No Vaccine	355	0	4,739	1,068	4739	43,656

Source: National Task Force of COVID-19 Control, 2021

Multivariate analysis (Multiple linear regression) result shows that in the final model, there were five variables remained associated with COVID-19 cases (p=0.000; R^2=0.896), namely percentage of traced cases (p=0,030; B= -6.926), cases had epicontact (p=0,000; B= 1.362), isolation drop out (p=0,003; B=2.644), COVID-19 vaccine dose-1 (p=0,024; B=0.380), and No COVID-19 vaccine (p=0,005; B=0.598). Meanwhile, there were three variables became confounders, consisted of close contact (p=0,160; B=-0.052), ratio of close contact: cases (p=0,405; B=-34.825), quarantine drop out (p =0,649; B=0.226) (Table 4).

Table 3. Correlation Between Selected Factors to COVID-19 Cases

Variable	*p*-value	r
Traced Cases	0.000	0.940
% Traced Cases	0.078	-0.233
Cases Have Epicontact	0.000	0.905
% Cases With Epicontact	0.545	-0.081
Close Contact	0.000	0.832
Ratio Close Contact: Cases	0.034	-0.278
Isolation Drop Out	0.000	0.679
Quarantine Drop	0.000	0.639
Testing For Close Contact	0.000	0.718
COVID-19 Vaccine Dose 1	0.000	0.721
COVID-19 Vaccine Dose 2	0.000	0.747
No Vaccine	0.000	0.825

Source: National Task Force of COVID-19 Control, 2021

Table 4. Predictors of COVID-19 Cases Based on Multivariate Linear Regression Modeling

Variable	B	*p value*	R^2
Constant	959.7	0.001	0.896
% Traced Cases	-6.926	0.030	
Cases Had Epicontact	1.362	0.000	
Close Contact	-0.052	0.160	
Ratio Close Contact: Cases	- 34.825	0.405	
Isolation Drop Out	2.644	0.003	
Quarantine Drop	0.226	0.649	
COVID-19 Vaccine Dose 1	0.380	0.024	
No COVID-19 Vaccine	0.598	0.005	

Source: National Task Force of COVID-19 Control, 2021

DISCUSSION

These study findings showed that, on average, there were 804 cases in each district with more than 103,000 total cases, or there were 2 cases a day in one district and 686 cases a day in all 58 districts. This number indicates that the transmission is still there and needs the effort of prevention and control. The central government must take over the handling of Covid-19 cases by involving local governments by forming a task force.[19] COVID-19 is one epidemic disease to be prevented and managed by national and local governments in Indonesia.[20] The government created a COVID-19 pandemic working group to successfully regulate and prevent the epidemic, as the Chinese government has done.[21] The working group then constructed a fever clinic and named a medical facility to oversee and treat COVID-19 patients. To support ongoing research projects and meet the objectives of limiting and preventing COVID-19 infections, this Working Group was created in a hurry. This working group executes the central government's directive and modifies it for local conditions by creating health policies and infection control-related actions. Additionally, this working group improves departmental communication and informs pertinent departments of the COVID-19 infection rate.

There are still people that leave isolation and quarantine, which are things that could cause more transmission. Suggests that cooperation between relevant stakeholders needs to be improved to guarantee that close contacts are quarantined for the proper amount of time and that cases are isolated more effectively. A Chinese study discovered that suspected and quarantined cases are the main factors driving epidemic developments. The total number of isolated and suspected cases has reached the forecasted peak, but the epidemic's inflection points have already been reached.[22] Report on a survey done by the UK's Office of National Statistics, which comprised observations of 895 people who had to isolate themselves after testing positive for COVID-19 between November 29 and December 4, 2021. Demonstrates that around three-quarters (74%) of people fully adhered to the rules throughout the self-isolation period, which is the same percentage as that reported in July (79%), September (78%), and November 2021 (75%). However, one in four people (25%) admitted to having done at least one activity during self-isolation that violated the rules, such as receiving guests and leaving the house.[23]

In term of close contact, there was 2,188 close contact in each district with a ratio to cases was 2.75 on average. This is a quite big number of close contact but the ratio is still low. This indicates that the number of closes contact should be increased to decrease the possibility of disease transmission. Tracers should optimize the effort of contact tracing collaborated with other parties, such as the head of the village, police, and Public Health Centers. Another finding showed that there were a number of cases that have not been vaccinated, indicating that vaccination should be scaled up to get her immunity. Moreover, not all cases had been traced for close contact (70%), and none had

epicontact (32%). This indicates contact tracing, again. Should be strengthened to get close contact with as many as possible. In addition, close contact tracing should also be carried out in correctional institutions. Although according to a study, the implementation of COVID-19 prevention in prisons was carried out well in most prisons in Indonesia.[24]

Contact tracing is a critical method to stop the spread of COVID-19. The endeavor to find close contacts is by the interim WHO guidelines and Ministry of Health recommendations on COVID-19 prevention and control.[4] Four indicators of contact tracing may include contact tracing processes that connect contacts to already-existing community resources to support quarantine, track or trace technology app uptake via the proportion of contact tracing-related apps, and the percentage of trained contact tracers.[25] The scope of indicators may be increased to include data on the population's adoption and use of digital proximity tracing, its ability to identify contacts at risk for infection, and the speed at which digital proximity tracing solutions can notify contacts in comparison to traditional contact tracing mechanisms, and the obstacles to and factors that support the use of digital proximity tracing methods.[26]

Several factors correlate with COVID-19 cases, namely the number of cases traced, cases with epicontacts, close contact, isolation drop out, quarantine drops out, close contact test, vaccine dose-1, vaccine dose-2, no vaccine, and close ratio contact: cases. In multivariate analysis, five factors were significantly associated with COVID-19 cases, namely percentage of traced cases, cases with epicontact, isolation drop out, COVID-19 vaccine dose-1, and No COVID-19 vaccine. A review study describes the evolving role of testing during the COVID-19 pandemic. Includes using genomic monitoring to monitor SARS-CoV-2 transmission globally, contact tracing to control disease outbreaks, and testing for the virus's presence in the environment. Although these initiatives, broad community transmission has established itself in many nations, necessitating population testing to detect and isolate infected people, many of whom are asymptomatic.[27]

According to systematic review research, contact tracing could either end an outbreak or reduce illnesses (by, for example, 24% to 71% using a mobile tracing app) under the assumptions of rapid and complete tracking with no additional transmission. Modeling studies revealed that tracing could reduce COVID-19 but not halt it under slower, less effective tracing conditions.[6] According to a US study, COVID-19 is disseminated by close contact and communal exposure. Being near people who have known COVID-19 or visiting places with on-site food and beverage options were linked to COVID-19 positive.[7] According to a study conducted in China, home interactions posed the most significant risk of contracting COVID-19, with an incidence rate of 10.2%. The incidence of COVID-19 increased along with the aging of close contacts and the severity of the source cases.[28]

Health quarantine of close contacts should be conducted as tight as possible, to decrease the risk of transmission. According to numerical simulations, a dynamic analysis of the model reveals that improved quarantine interventions can help limit the spread of COVID-19, likely to stop outbreaks in the general population.[9] According to a study conducted in India, just 7.43% of children and adolescents complied with all standards, though community protective measures were more frequently followed (17.35%) than household protective measures (10.71%).[29] The place of quarantine may be considered as comfortable as has possible. A study shows that the place had an influence on the quarantine period for nurses exposed to Covid-19.[30] Health quarantine to prevent epidemic is a way to avoid the epidemic prone disease spread. Despite the scant data, quarantine was proven to be crucial in lowering the number of infections and fatalities. Quarantine was most efficient and affordable when it started sooner. However, quarantine alone might not be as effective as quarantine combined with other prevention and control techniques.[31]

The vaccine of COVID-19 as a new vaccination program is an effort to increase immunity against the virus. Several studies in the United States have reported that vaccination is substantially effective in reducing the risk of COVID-19 and is associated with a substantial reduction in hospitalizations, risk of severity/crisis, and COVID-19-related mortal-

ity.[10–16] Vaccination has been linked to decreased non-COVID-19 mortality rates and direct decreases in COVID-19-related morbidity and mortality, proving that doing so does not raise the risk of death.[32] However, several strategies have been used to boost vaccination rates, including broadening the target population and making vaccines more accessible. Although many strategies have been used to boost vaccination rates, such as broadening the target population and making vaccinations more accessible,[33] vaccine hesitancy and rejection require other approaches. Many psychological factors cause vaccine rejection and doubt, such as personality traits,[34] doubts about halal vaccines (religion rules),[35] lack of public trust in health professionals, scientists, and the government, and cognitive reflection.[36,37] The central, provincial, and district/city governments provide guidance and supervision on implementing the COVID-19 Vaccination Technical Guidelines. Despite vaccination, it must maintain public health mitigation efforts: distancing, masks, avoiding indoor congregation, and prioritizing good air ventilation. [38]

CONCLUSION AND RECOMMENDATION

Percentage of traced cases, cases had epicontact, isolation drop out, COVID-19 vaccine dose-1, and no COVID-19 vaccine were significantly associated with COVID-19 cases. Identifying factors related to the incidence of COVID-19 when cases tend to decline is very important to increase efforts to prevent and control COVID-19 cases in the community as a response to the alertness of new cases due to the emergence of new variants. It can also be used to guide the implementation of public health intervention measures aimed at limiting the impact of the pandemic, particularly on vulnerable populations.

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AUTHOR CONTRIBUTIONS

MW drafted this paper with contributions from all authors. MW, WR, DL contributed in data acquisition. MW, WR, and DL contributed to data extraction and analysis. AK and YFW contributed in proofreading. All authors reviewed the findings or contributed to the interpretation and discussion. All authors agreed with the final version of the paper. MW = Mugi Wawan; WR = Wawan Ridwan; DL = Doni Lasut; AK = Aan Kurniawan; YFW = Yurika Fauzia Wardhani.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

1. Kemenkes RI. Situasi Terkini Perkembangan Coronavirus Disease (COVID-19). Jakarta: Kementrian Kesehatan RI; 2022.
2. Presiden RI. Keputusan Presiden Republik Indonesia Nomor 7 Tahun 2020 Tentang Gugus Tugas Percepatan Penanganan Corona Virus Disease 2019 2019 (COVID-19). 2020. Jakarta
3. Kemenkes RI. Keputusan Menteri Kesehatan Republik Indonesia Nomor HK.01.07/MenKes/413/2020 Tentang Pedoman Pencegahan dan Pengendalian Corona Virus Disease 2019 (Covid-19). Vol. 2019, MenKes/413/2020; 2020.
4. WHO. Critical Preparedness, Readiness, and Response Actions for COVID-19. Geneva: WHO; 2020
5. WHO. Overview of Public Health and Social Measures in the Context of Covid-19. Geneva: WHO; 2020
6. Juneau CE, Briand AS, Pueyo T, Collazzo P, Potvin L. Effective Contact Tracing for COVID-19: A Systematic Review. *Global Epidemiology.* 2023:(5). https://doi.org/10.1016%2Fj.gloepi.2023.100103

7. Fisher KA, Tenforde MW, Feldstein LR, Lindsell CJ, Shapiro NI, Clark ; D, et al. Morbidity and Mortality Weekly Report Community and Close Contact Exposures Associated with COVID-19 Among Symptomatic Adults ≥18 Years in 11 Outpatient Health Care Facilities-United States, July 2020. *MMWR Morbidity Mortality Weekly Report*. 2020;(36):1258–1264. https://doi.org/10.15585/mmwr.mm6936a5

8. Murugesan M, Venkatesan P, Ramasamy J, Samuel P, Karthik R, Rose W, et al. Transmission Dynamics of Covid-19 and Utility of Contact Tracing in Risk Assessment of Health-Care Worker Exposure During COVID-19 Pandemic. *Indian Journal Community Medicine*. 2022;47(1):82. https://doi.org/10.4103%2Fijcm.ijcm_1097_21

9. Resmawan R, Nuha AR, Yahya L. Analisis Dinamik Model Transmisi COVID-19 dengan Melibatkan Intervensi Karantina. *Jambura Journal of Mathematics*. 2021;3(1):66–79. https://doi.org/10.34312/jjom.v3i1.8699

10. Vasileiou E, Simpson CR, Shi T, Kerr S, Agrawal U, Akbari A, et al. Interim Findings from First-Dose Mass COVID-19 Vaccination Roll-Out and COVID-19 Hospital Admissions in Scotland: A National Prospective Cohort Study. *Lancet*. 2021;397(10285):1646–1657. https://doi.org/10.1016/S0140-6736(21)00677-2

11. Haas EJ, Angulo FJ, McLaughlin JM, Anis E, Singer SR, Khan F, et al. Impact and Effectiveness of mRNA BNT162b2 Vaccine Against SARS-CoV-2 Infections and COVID-19 Cases, Hospitalisations, and Deaths Following A Nationwide Vaccination Campaign in Israel: An Observational Study Using National Surveillance Data. *Lancet*. 2021;397(10287):1819–1829. https://doi.org/10.1016/S0140-6736(21)00947-8

12. Thompson MG, Stenehjem E, Grannis S, Ball SW, Naleway AL, Ong TC, et al. Effectiveness of Covid-19 Vaccines in Ambulatory and Inpatient Care Settings. *The New England Journal of Medicine*. 202;385(15):1355–1371. https://doi.org/10.1056/nejmoa2110362

13. McNamara LA, Wiegand RE, Burke RM, Sharma AJ, Sheppard M, Adjemian J, et al. Estimating the Early Impact of the US COVID-19 Vaccination Programme on COVID-19 Cases, Emergency Department Visits, Hospital Admissions, and Deaths Among Adults Aged 65 Years and Older: An Ecological Analysis of National Surveillance Data. *Lancet*. 2022;399(10320):152–160. https://doi.org/10.1016/S0140-6736(21)02226-1

14. Ioannou GN, Locke ER, O'Hare AM, Bohnert ASB, Boyko EJ, Hynes DM, et al. COVID-19 Vaccination Effectiveness Against Infection or Death in a National U.S. Health Care System : A Target Trial Emulation Study. *Annals of Intern Medicine*. 2022;175(3): 352–361. https://doi.org/10.7326/m21-3256

15. Tenforde MW, Self WH, Gaglani M, Ginde AA, Douin DJ, Talbot HK, et al. Effectiveness of mRNA Vaccination in Preventing COVID-19-Associated Invasive Mechanical Ventilation and Death - United States, March 2021-January 2022. *MMWR Morbidity Mortality Weekly Report*. 2022;71(12):459–465. https://doi.org/10.15585/mmwr.mm7112e1

16. Subramanian S V, Kumar A. Increases in COVID-19 are Unrelated to Levels of Vaccination Across 68 Countries and 2947 Counties in the United States. *European Journal of Epidemiology*. 2021;36(12): 1237–1240. https://doi.org/10.1007%2Fs10654-021-00808-7

17. Hastono SP. Analisis Data. Depok: Fakultas Kesehatan Masyarakat Universitas Indonesia; 2006.

18. Kleinbaum DG et al. Applied Regression Analysis and Other Multivariable Methods. California: Duxbury Press; 1998.

19. Katharina R. Relasi Pemerintah Pusat-

Pemerintah Daerah dalam Penanganan COVID-19. *Info Singkat*. 2020;8(5):25–30.

20. Peraturan Pemerintah RI. Undang-Undang Nomor 4 Tahun 1984 tentang Wabah Penyakit Menular. 1984. Jakarta.
21. Fan S, Wu M, Ma S, Zhao S. A Preventive and Control Strategy for COVID-19 Infection: An Experience From a Third-Tier Chinese City. *Frontiers Public Health*. 2020;8(October):1–6. https://doi.org/10.3389/fpubh.2020.562024
22. Tang B, Xia F, Tang S, Bragazzi NL, Li Q, Sun X, et al. The Effectiveness of Quarantine and Isolation Determine the Trend of the COVID-19 Epidemics in the Final Phase of the Current Outbreak in China. *International Journal of Infectious Diseases*. 2020;96:636–647. https://doi.org/10.1016%2Fj.ijid.2020.05.113
23. Mahase E. Covid-19: Is It Safe To Reduce The Self-Isolation Period?. *BMJ*. 2021;37:3164. https://doi.org/10.1136/bmj.n3164
24. Wahidin M, Pane M, Angkasawati TJ. Prevention Measures of COVID-19 in Prisons in Indonesia. *Asia-Pacific Journal of Public Health*. 2022;34(5):573–575. https://doi.org/10.1177/10105395221088654
25. WHO. Operational Guide for Engaging Communities in Contact Tracing. Geneva: WHO; 2021.
26. WHO/ECDC. Indicator Framework to Evaluate the Public Health Effectiveness of Digital Proximity Tracing Solutions. Geneva: WHO; 2021.
27. Mercer TR, Salit M. Testing at scale during the COVID-19 pandemic. *Nature Review Genetics*. 2021;22(7):415–426. https://doi.org/10.1038/s41576-021-00360-w
28. Luo L, Liu D, Liao X long, Wu X bo, Jing Q long, Zheng J zhen, et al. Modes of Contact and Risk of Transmission in COVID-19 among Close Contacts. Digital Economies at Global Margins. Southern Medical University, Guangzhou, Guangdong, China; 2020. https://doi.org/10.7326/m20-2671
29. Saurabh K, Ranjan S. Compliance and Psychological Impact of Quarantine in Children and Adolescents due to Covid-19 Pandemic. *Indian Journal of Pediatrics*. 2020;87(7):532–536. https://doi.org/10.1007/s12098-020-03347-3
30. Winugroho T, Imansyah M, Bangun E, Apriyadi RK, Hidayat A. Analisis Pengaruh Faktor Demografi terhadap Lama Karantina pada Perawat Terpapar Covid-19 di Jawa Tengah. *PENDIPA Journal of Science Education*. 2021;5(2):229–236. https://doi.org/10.33369/pendipa.5.2.229-236
31. Nussbaumer-Streit B, Mayr V, Dobrescu AI, Chapman A, Persad E, Klerings I, et al. Quarantine Alone or in Combination with other Public Health Measures to Control COVID-19: A Rapid Review. *The Cochrane Database of Systematic Reviews*. 2020;9 (9):CD013574. https://doi.org/10.1002/14651858.cd013574
32. Xu S, Huang R, Sy LS, Glenn SC, Ryan DS, Morrissette K, et al. COVID-19 Vaccination and Non-COVID-19 Mortality Risk - Seven Integrated Health Care Organizations, United States, December 14, 2020-July 31, 2021. *MMWR Morbidity Mortality Weekly Report*. 2021;70(43):1520–1524. https://doi.org/10.15585/mmwr.mm7043e2
33. Minister of Health. Minister of Health Regulation No. 18 of 2021: Amendment to the Regulation of the Minister of Health Number 10 of 2021 Concerning the Implementation of Vaccination in the Context of Combating the 2019 Corona Virus Disease (Covid-19) Pandemic. Indonesia; 2021.
34. Patty NJS, Van Dijk HM, Wallenburg I, Bal R, Helmerhorst TJM, Van Exel J, et al. To Vaccinate or Not to Vaccinate? Perspectives on HPV Vaccination Among Girls, Boys, and Parents in the Netherlands: A Q-methodological study. *BMC Public Health*. 2017;17(1):1–12.

https://doi.org/10.1186%2Fs12889-017-4879-2

35. Effendi D, Laksono A, Pranata S, Nantabah Z. Prevalence and Factors Associated with Belief in COVID-19 Vaccine Efficacy in Indonesia: A Cross-Sectional Study. *Asian Pacific Journal of Tropical Medicine*. 2022;15(7):308–313. https://doi.org/10.4103/1995-7645.351769
36. Xiong Y, Zhao Y, Zhang T, Wang Q, Liu JA. Factors Associated With the Vaccination Behavior Among COVID-19 Vaccine Hesitant College Students in Wuhan, China: A Survey Based on Social Psychological Dimension. *Frontiers in Public Health*. 2022;10:1–11. https://doi.org/10.3389%2Ffpubh.2022.865571
37. Yanto TA, Octavius GS, Heriyanto RS, Ienawi C, Nisa H, Pasai HE. Psychological Factors Affecting COVID-19 Vaccine Acceptance in Indonesia. *Egypt Journal of Neurology, Psychiatry and Neurosurgery*. 2021;57 (1):177. https://doi.org/10.1186/s41983-021-00436-8
38. Ophinni Y, Hasibuan AS, Widhani A, Maria S, Koesnoe S, Yunihastuti E, et al. COVID-19 Vaccines: Current Status and Implication for Use in Indonesia. Acta Med Indones. 2020;52(4):388–412. https://www.actamedindones.org/index.php/ijim/article/view/1648

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Potential of Noni Leaf Extract (*Morinda citrifolia L.*) As *Aedes aegypti* Mosquito Repellent

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ABSTRACT
Dengue fever is transmitted every year by the *Aedes aegypti* mosquitoes in Indonesia. One way to prevent this is by using repellents, such as the noni leaf extract (*Morinda citrifolia L.*). The objective of this study was to analyze the potential of the noni fruit (*Morinda citrifolia L.*) leaf extract as a repellent against *Aedes aegypti*. The study employed a post-test research design with only a control group, using concentrations of 12.5%, 25%, and 37.5%, and 25 mosquitoes with 6 repetitions. The technique for data collection involved counting mosquitoes that perched on hands. The study was conducted from November 2022 to May 2023. Data analysis was performed using SPSS Anova One Away Post Hoc and the power protection formula. The research on *Aedes aegypti* mosquitoes that perched for 6 hours showed that the noni leaf extract concentration of 37.5% had an average of 2.5 tails perched. The concentration of the noni leaf extract is 37.5%, according to the Pesticide Committee standard (1995). The average protection power for 6 hours is 90.86%. The study also suggests investigating the side effects of use and the addition of an HPMC gelling agent. However, for concentrations of 12.5% and 25%, the protective power is less than 90%. This study shows that concentrations of 37.5% are effective for repelling *Aedes aegypti* mosquitoes. Further research can be conducted using old or yellowed leaves, as well as for repelling culex and *Anopheles* mosquitoes.

INTRODUCTION

According to data from the Ministry of Health of the Republic of Indonesia, the frequency of dengue occurrences has fluctuated significantly. The Case Fatality Rate (CFR) increased from 0.70% in 2020 to 0.95% in 2021.[1,2] In 2022, the percentage decreased from 0.90% to 0.86%.[3] Dengue fever is transmitted by the *Aedes aegypti* or *Aedes albopictus* mosquito vector.[4] DHF is influenced by various factors, including the host, pathogen, and environment. It is a concept known as the Epidemiological Triangle.[5,6]

The high number of dengue cases in Indonesia necessitates a dengue eradication program that prioritizes the suppression of dengue vector populations through environmental.[7] A poor environment can lead to the formation of puddles, which can serve as breeding improvements grounds for *Aedes aegypti* larvae. The presence of *Aedes aegypti* larvae is strongly associated with the incidence of dengue fever in the region.[8] The use of insecticides to control *Aedes aegypti* mosquitoes may lead to the mosquitoes developing resistance to them.[9,10] The most effective way to achieve this is through the mosquito nests eradication movement. To prevent dengue fever, it is recommended to apply safe lotions and use repellents.[11,12]

Repellents are substances used to repel insects and other animals and prevent their bites and stings on humans.[13] The noni plant (*Morinda citrifolia L.*) can be used as a repellent. Its leaves contain alkaloids, saponins, flavonoids, tannins, polyphenols, ethanol and glycosides, which can be used as a repellent. Furthermore, noni is one of the plants that can produce essential oils.[14,15] Flavonoids are polyphenolic compounds that occur naturally in fruits, vegetables, and cereals. They possess antioxidant, antimicrobial, and anti-inflammatory properties. Flavonoids are odorous and can cause nerve atrophy.[16] Saponins can cause hemolytic reactions that destroy red blood cells, resulting in membrane damage.[17] Alkaloids are compounds with an alkaline nature. They increase the demand for oxygen and cause paralysis in insects, which makes them effective as insect repellents.[18]

Previous research has shown that the noni fruit (*Morinda citrifolia L.*) can act as a repellent for *Aedes aegypti* mosquitoes, which are vectors of dengue fever, chikungunya, and zika. The study also found that noni leaves were effective against malaria, filariasis, and encephalitis mosquitoes.[19,20] The noni fruit contains saponins and flavonoids, which have an insecticidal effect while the noni leaves contain alkaloid chemicals, saponins, flavonoids, tannins, polyphenols, ethanol and glycosides. These compounds have the potential to act as antibacterial agents against *Escherichia coli* and *Salmonella typhimurium*. The betel plant extract (*Piper betle, L.*) contains chemical compounds such as saponins, flavonoids, tannins, eugenol, cavicol, and alkaloids that have been proven to repel the *Aedes aegypti* mosquito.[21,22] The objective of this study was to analyze the protective effect of the noni leaf extract as a repellent against *Aedes aegypti*.

MATERIAL AND METHOD

This study employed a purely experimental approach, specifically a true experiment, and utilized a simple design with a posttest-only control group. The study population consisted of 25 *Aedes aegypti* mosquitoes. Samples of 25 randomly selected female mosquitoes aged 3-5 days were used. The methodology employed was based on the efficacy test of repellents on human skin, following the WHO 2009 standards.[23]

The study involved observing the number of mosquitoes perched for 5 minutes every hour over a period of 6 hours in both the control and treatment groups. The Federer formula was used for the calculation.[24] Each treatment was replicated six times.

$$(t-1)(n-1) > 15$$

Description:
t = number of groups
n = number of subjects per group

Ingredients

Noni leaf extract was used, extracted by maceration. A total of 25 *Aedes aegypti* mosquitoes were used in the test, which took place in a cage. The necessary equipment included a plastic cup, a counter, a stopwatch, an aspirator, cotton, latex gloves, Aquades, ethanol 96%, a wet towel, a paper cup, and sugar water.

Noni extract process

The noni leaf extract was created with a concentration of 50% (weight/volume). To dry the noni leaves, place them in an oven at 105°C.

Once dry, crush and sift the leaves into a powder. Weigh 500 grams of the noni leaf powder and place it in a maceration container. Soak the powder in 1000 ml of 96% ethanol solvent (the ratio of noni leaf powder to ethanol is 1:2) until it is completely submerged. Let the maceration vessel containing Simplisa stand for 24 hours, stirring occasionally. After 24 hours, the extract is filtered to obtain the filtrate. In the final step, the remaining filtrate is filtered again and 96% 1:2 ethanol solvent is added. The mixture is left for 24 hours and the noni leaf extract is then diluted to 50% (w/v).

Dilution

The concentrations used in this experiment were 12.5% (volume/volume), 25% (v/v) and 37.5% (v/v). The following dilution formula was used to calculate the concentration of the noni leaf extract.[25]

$$C1 \times V1 = C2 \times V2$$

Description:
C = The Product of Concentration
V = Volume

Experimental procedure

This experimental procedure is sourced from the World Health Organization (WHO), 2009. To begin, prepare a mosquito cage measuring 35-40 cm on each side. Each cage should contain 25 female *Aedes aegypti* mosquitoes that have not been fed for 24 hours prior to testing. One cage should be used for testing repellents, while the other will serve as a positive control. Before testing, it is important to wash your hands with unscented soap and rinse them thoroughly with water. Finally, rinse your hands with a 70% alcohol solution. During testing, the hands are protected by gloves made of materials that cannot be penetrated by mosquito bites. Latex gloves are commonly used for this purpose. The next steps involve using the left hand as a control, which is not given any treatment, and placing it in the cage for 15, 30, 45, and 60 minutes at 15-minute intervals. The number of mosquitoes perching on the hand is then counted. The right arm is then smeared with noni leaf extract at concentrations of 12%, 25%, and 37.5%.

The following steps were taken to conduct the experiment: First, the right arm was entered as a control and given noni leaf extract. The extract was then inserted into the cage and the number of mosquitoes was counted. This process was repeated six times. Next, each replication was performed by replacing the mosquitoes with new ones. At the end of the experiment, the number of mosquitoes collected during each observation period was averaged for each repetition. Finally, the temperature and humidity were measured using a hygrometer and thermometer.

Data Analysis

The study was analyzed using SPSS 16.0 software. The level of significance was set at 0.05 (p=0.05) with a confidence level of 95% (α=0.05). The noni leaf extract concentrations were tested for their ability to repel *Aedes aegypti* mosquitoes using the one-way analysis of variance (ANOVA) followed by post-hoc tests to determine significantly different groups.[26] The level of protection was calculated by using the following formula.[27]

$$DP = \frac{K - P}{K} \times 100\%$$

Description:

DP	: Repellent
K	: The number of mosquitoes perched in the therapeutic arm
P	: number of mosquitoes perched on the negative control

According to the Pesticide Commission (1995), power protection is considered effective if it can provide 90% protection for up to 6 hours.[28] The research conducted was approved by the Surabaya Health Polytechnic Ethics Committee under the number EA/1427/KEPK – Poltekkes_Sby/V/2023.

RESULTS

Noni (*Morinda citrifolia L.*) exhibits bioactive properties. Table 1 demonstrates that the noni leaf extract offers protection against *Aedes aegypti* mosquito bites. The results suggest the potential use of noni leaf extract as an effective mosquito repellent agent, which could have a positive impact on controlling diseases spread by this vector.

The study has demonstrated that the noni leaf extract lotion has protective properties against *Aedes aegypti* mosquitoes for up to 6 hours. The lotion was found to repel mosquitoes with an

average of 74.85% at a concentration of 12.5%, 84.86% at 25%, and 90.86% at 37.5% (Table 1).

The one-way analysis of variance (ANOVA) test results at concentration variations of 12.5%, 25%, and 37.5% indicate a significant difference in protective power between treatment groups (p <0.05). A post hoc test is required to determine which pairs of groups are specifically different from each other. Table 2 displays the results of post hoc tests on concentration variations.

The post hoc test revealed significant differences in protective power among the treatment groups of 12.5%, 25%, and 37.5% (p<0.05). The table indicates that the greater the concentration of noni leaf extract, the greater the protection against the *Aedes aegypti* mosquito.

DISCUSSION

The control group had a higher number of mosquitoes landing on them than the other treatments due to the lack of repellent. In contrast, the noni leaf extract treatment group had fewer mosquitoes perching. This suggests that the active compounds in noni leaves affect the perching behavior of *Aedes aegypti* mosquitoes. The noni leaf extract contains active ingredients, including flavonoids, tannins, quinines, saponins, alkaloids and triterpenoids, which have mosquito-repellent properties.

Table 1. Average Protection Power of Noni Leaf Extract as *Aedes aegypti* Mosquito Repellent

Hours	Protection Power Percentage (%)			
	Control	12.5%	25%	37.5%
1	0	74.6	86	93.3
2	0	76.6	84.6	90.6
3	0	77.3	86	92
4	0	76	84	90
5	0	73.3	84.6	90
6	0	71.3	84	89.3
Amount	0	449.1	509.2	545.2
Average	0	74.85	84.86	90.86

Source: Primary Data, 2023

Table 2. Post Hoc Test Results in the Treatment Group

Repellent	Probability		
	12,5%	25%	37,5%
12,5%		0.030	0.029
25%	0.030		0.045
37,5%	0.029	0.045	

Source: Primary Data, 2023

The large number of mosquitoes perched on them contributes to the high humidity, as evaporation from the mosquito's body accelerates air loss.[29] The humidity in this study was around 66%, which is within the range of 60-80%. Optimal humidity (60-80%) can facilitate the reproductive activity and development of mosquito eggs. Therefore, these humidity conditions can increase the population of *Aedes aegypti* mosquitoes which, in turn, can increase the risk of disease transmission by these mosquitoes. As well as humidity, temperature is an important factor. Mosquitoes prefer warm environments and body temperature can affect the number of active mosquitoes. Mosquitoes are more active at higher temperatures.[30]

The feeding behavior of mosquitoes is influenced by several factors, including heat, humidity, odor, CO2 concentration and visual stimuli. Dark or light colors can also affect the visual stimulation of mosquitoes. Mosquitoes prefer dark colors, so the presence of dark-colored objects or people may be more attractive to them.[29]

Several studies show that flavonoids, tannins, quinines, saponins, alkaloids and triterpenoids have mosquito-repellent properties. Flavonoids belong to the phenolic compounds. Phenolics are compounds with hydroxyl groups in the form of aromatic rings and are very important for use as insecticides and repellents.[31] Phenolic compounds are most abundant in upland plants.[32] The use of noni leaves (*Morinda citrifolia L.*) as an *Aedes aegypti* repellent has never been studied, but other parts of the noni plant have been studied. Previous research concluded that noni fruit (*Morinda citrifolia L.*) has a protective effect of 93.33%, which can be considered effective because the protective effect exceeds 90%.[21,33]

The repellent properties of the ethanolic extract of the noni fruit are probably due to the active compounds it contains, such as flavonoids, tannins, saponins, alkaloids and glycosides. Flavonoid compounds, tannins, alkaloids and saponins can control the *Aedes aegypti* mosquitoes and the most effective in preventing mosquitoes from landing are alkaloids.[34]

This difference is due to the amount of active chemicals contained in each concentration of the

noni leaf extract. The higher the concentration of active ingredients in the noni leaf extract, the greater its effectiveness in protecting the skin from mosquito bites.[35]

Alkaloid compounds are derivatives of aldehydes; aldehydes and ketones have a distinctive odor that is thought to stimulate the nerves of mosquitoes, causing them to leave the sample.[36]

The dominant characteristic odor of alkaloids is detected by mosquito antennae with sensilla, which *Aedes aegypti* mosquitoes possess. Sensilium has a complex of olfactory receptor nerves called ORNs (Olfactory Receptor Neurons). Then, alkaloids from noni leaves are translated by the mosquitoes' brains (lobe antennae) into non-attracting molecules so that the mosquitoes are not attracted and avoid them. After this process, the OBP is triggered to provide odor molecules from typical alkaloids to reduce olfactory sensitivity to the attractant molecules. This OBP complex travels through the lymph fluid to the dendrites and binds to the or (olfactory receptor), which is then delivered to the brain center. Finally, it produces behavioral responses that change to keep away from the odor.[36]

Power Protection Repellent Noni leaf extract at a concentration of 37.5% provided an average protection of over 90% for 6 hours. Noni leaf extract at concentrations of 12.5% and 25% gave an average protection of less than 90% for 6 hours. The noni leaf extract at 37.5% is worthy of being called repellent and more effective in the range of power protection because the concentration of 37.5% has a range of 89.3-93.3%, which is higher than the concentration of 12.5% at 71.3%-77.3% and the concentration of 25% at 84%-86%. According to the Pesticide Commission (1995), a repellent can be said to be effective if the lowest level of protection can reach 90% for 6 hours.[37]

Concentrations of 12.5% and 25% in the first hour to six hours are not optimal for repelling the *Aedes aegypti* mosquito, providing less than 90% protection, because high dispersibility also promotes a rapid release of the active ingredient. The evaporation of chemical compounds contained in the noni leaf extract increases over time, causing the odor of the noni extract to disappear, leading to a decrease in the repellent potential.[38]

The protective power of the noni leaf extract will decrease over time in its ability to repel mosquitoes. This is due to the resistance of the aroma extract to evaporation. The lower the protective power, the lower the repellent power of the noni leaf extract.[39]

The flavonoids, tannins, saponins, alkaloids and glycosides contained in the noni leaf extract (*Morinda citrifolia L.*) are effective in repelling mosquitoes. The odor emitted by plant extracts, fruits and seeds is a terpenoid compound that is thought to act as a mosquito repellent. Flavonoid compounds have the ability to pass through the cuticle lining of the mosquito's body, so they can damage the mosquito's respiratory system.[40]

The active ingredient in noni leaves can prevent mosquitoes from landing on arms. The most effective concentration is 37.5% noni leaf extract (*Morinda citrifolia L.*) with a proven protection of 93.33%. It also suggests that the higher the concentration, the higher the active ingredient in the noni leaf, which may discourage *Aedes aegypti* from colonizing. This is supported by previous researchers who suggested that the more active ingredient added, the greater the protective effect.[38] The higher the concentration of the extract used, the lower the average number of mosquito habitats.[13]

With concentrations ranging from 12.5% to 25%, research shows that the noni leaf extract has promising potential as a natural repellent. The optimal concentration of 37.5% indicates higher efficacy, making it an attractive alternative to protect against insect bites. The noni leaf extract repellent can be used as a replacement for synthetic repellents, which can have negative long-term effects on human health. As a natural ingredient, the noni leaf extract is expected to provide a safe and effective solution to insect pests. In addition to the health benefits, the use of natural ingredients also supports environmental conservation efforts. The fact that the noni leaf extract repellent can be stored for up to a month makes it a practical and effective option. Choosing this solution not only supports human health, but also maintains harmony with the environment.

The addition of a gelling agent offers an alter-

native to increase protection for 6 hours. The gelling agent is a hydrocolloid substance that can increase the viscosity and stabilize the gel preparation.[41] Gel preparations in future studies can use HPMC (Hydroxypropyl Methyl Cellulose) as a gel base. The physical stability of antiseptic hand sanitizer gel using preservatives in the form of methylparaben base gel in the form of HPMC can provide good standardization of stability requirements in accordance with the specifications set by Indonesia (SNI 06-2588-1992).

CONCLUSION AND RECOMMENDATION

The noni leaf extract (*Morinda citrifolia L.*) has been shown to be an effective repellent against *Aedes aegypti* mosquitoes. Furthermore, the 37.5% concentration was found to be most effective in providing protection against *Aedes aegypti* mosquitoes for up to 6 hours, with an average protection of 90.86% and a range of 89.3-93.3%.

The recommendations are for the public to consider using noni leaves in vector control efforts as noni leaves contain caproic acid, octanoic acid and decanoic acid, which can be extracted using ethanol or citric acid as a solvent. Although noni leaves have an unpleasant ammonia-like odor, this can be removed during the extraction process.

More research is needed on the effectiveness of the noni leaf extract as a repellent for mosquitoes such as *Culex quinquefasciatus* and *Anopheles*. In addition, the long-term side effects of using noni leaves need to be studied. Another area for further research is the addition of a gelling agent to the noni leaf extract to increase its energy-protecting properties for up to 6 hours.

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AUTHOR CONTRIBUTIONS

DN and LF organized and planned the research; LF and MS conducted the research in this area; LF, N, and M analyzed the data; LF, MS and DN discussed the results; LF, SW and N wrote the paper; SW, IS, and DN composed the article. DN = Demes Nurmayanti; LF = Lailatul Fithriyah; MS = Mahawiraja Setiawan; N = Ngadino; SW = Slamet Wardoyo; M = Marlik; IS = Irwan Sulistio.

CONFLICTS OF INTEREST

The authors state that no conflict of interest exists.

REFERENCES

1. Kemenkes RI. Indonesian Dengue Fever Annual Report 2022. Jakarta: Kementerian Kesehatan Republik Indonesia. 2022. 17–19. https://p2p.kemkes.go.id/wp-content/uploads/2023/06/FINAL_6072023_Layout_DBD-1.pdf
2. Zeng Z, Zhan J, Chen L, Chen H, Cheng S. Global, Regional, and National Dengue Burden from 1990 to 2017: A Systematic Analysis Based on the Global Burden of Disease Study 2017. *EClinicalMedicine*. 2021;32:100712. https://doi.org/10.1016/j.eclinm.2020.100712
3. Kemenkes RI. Indonesia Health Profile 2019. Jakarta: Kementerian Kesehatan Republik Indonesia. 2019. https://pusdatin.kemkes.go.id/resources/download/pusdatin/profil-kesehatan-indonesia/Profil-Kesehatan-indonesia-2019.pdf
4. Atikasari E, Sulistyorini L. Control of Aedes Aegypti Mosquito Vectors in Surabaya City Hospital. *Indonesian Journal of Public Health*. 2019;13(1):73. https://doi.org/10.20473/ijph.v13i1.2018.73-84
5. Zerfu B, Kassa T, Legesse M. Epidemiology, Biology, Pathogenesis, Clinical Manifestations, and Diagnosis of Dengue Virus Infection, and its Trend in Ethiopia: A

Comprehensive Literature Review. *Tropical Medicine and Health*. 2023;51(1). https://doi.org/10.1186/s41182-023-00504-0

6. Izza BA, Nurmayanti D, Mirasa YA. Spatial Analysis of the Effect of House Index with DHF Cases in Bangilan District, Tuban Regency. *BALABA*. 2022;18(2):149–158. https://journalkolegium.epidemiologi.id/index.php/kei/article/view/82
7. Murwanto B, Trigunarso SI, Purwono P. Factors of Social Environment, Physical Environment, and Control of DHF Programme on the Incidence of Dengue Fever (DHF). *Jurnal Kesehatan*. 2019;10(3):453. http://ejurnal.poltekkes-tjk.ac.id/index.php/JK
8. Nurmayanti D, Mukarromah HN, Marlik, Ane R La. Geographic Distribution of DHF Cases and Larvae Free Index In Situbondo Regency, 2019-2021. *Media Kesehatan Masyarakat Indonesia*. 2023;19(1):9–18. https://journal.unhas.ac.id/index.php/mkmi/article/view/22633
9. Ngadino, Marlik, Nurmayanti D. Resistance of Aedes aegypti Mosquitoes to Cypermethrin. *Jurnal Kesehatan Lingkungan Poltekkes Kemenkes Surabaya*. 2021. http://repo.poltekkesdepkes-sby.ac.id/3751/
10. Nurmayanti D. Conventional Detection of Resistance of Aedes aegypti Larvae as DHF Vector in Kediri District Against Temephos. *Indian Journal of Forensic Medicine and Toxicology*. 2020;14(1):2016–2019. https://www.academia.edu/108881857/Conventional_Detection_of_Resistance_of_Aedes_aegypti_Larvae_as_DHF_Vector_in_Kediri_District_Against_Temephos
11. Norris EJ, Coats JR. Current and Future Repellent Technologies: The Potential of Spatial Repellents and Their Place in Mosquito-Borne Disease Control. *International Journal of Environmental Research and Public Health*. 2017;14(2). https://doi.org/10.3390%2Fijerph14020124
12. Logan J. An Expert Review of Spatial Repellents for Mosquito Control. *Innovative Vector Control Consortium*. 2020;(August): 1–72. https://www.ivcc.com/wp-content/uploads/2020/08/An-Expert-Review-of-Spatial-Repellents-for-Mosquito-Control.pdf
13. Oktari F, Ahyanti M, Yushananta P. Analysis of the Potential of Clove Leaf Extract (*Syzygium aromaticum*) as a Mosquito Repellent. *Ruwa Jurai: Jurnal Kesehatan Lingkungan*. 2022;16(2):66–74. http://dx.doi.org/10.26630/rj.v16i2.3490
14. Putri AV, Hajimi H, Akhmad Z. Effectiveness of Noni Fruit Extract (*Morinda citrifolia*) as a Vegetable Pesticide for Control of Mice (*Mus musculus*). *Ruwa Jurai: Jurnal Kesehatan Lingkungan*. 2021;15(3):144–148. https://ejurnal.poltekkes-tjk.ac.id/index.php/JKESLING/article/viewFile/3068/1469
15. Sandra T, Sofro MA, Suhartono S, Martini M, Hadisaputro S. Factors Influencing the Incidence of Dengue Fever in Children Aged 6-12 Years in Tembalang Sub-district Dengue in Children aged 6-12 Years in Tembalang Sub-district. *Jurnal Epidemiologi Kesehatan Komunitas*. 2019;9(1):28–35. https://dx.doi.org/10.14710/jekk.v4i1.4423
16. Safe S, Jayaraman A, Chapkin RS, Howard M, Mohankumar K, Shrestha R. Flavonoids: Structure–Function and Mechanisms Of Action and Opportunities for Drug Development. *Toxicological Research*. 2021;37(2):147–162. https://doi.org/10.1007/s43188-020-00080-z
17. Paarvanova B, Tacheva B, Savova G, Karabaliev M, Georgieva R. Hemolysis by Saponin Is Accelerated at Hypertonic Conditions. *Molecules*. 2023;28(20):1–14. https://doi.org/10.3390/molecules28207096
18. Kurniawan VR, Mutiarawati DT, Endarini LH, Sasongkowati R. Efficacy of Different Betel Leaf Extracts As Repellents Against Aedes Aegypti Mosquito Bites. *Manuju: Malahayati Nursing Journal*. 2022;4(10): 2564–2572. http://dx.doi.org/10.33024/mnj.v4i10.751

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19. Ilham R, Lelo A, Harahap U, Widyawati T, Siahaan L. The Effectivity of Ethanolic Extract From Papaya Leaves (Carica papaya L.) as an Alternative Larvacide to Aedes spp. *Open Access Macedonian Journal of Medical Sciences*. 2019;7(20):3395–3399. https://doi.org/10.3889%2Foamjms.2019.432
20. Martias I, Simbolon VA. Noni and Papaya Leaf Extracts as Natural Larvicides on Aedes aegypti Mosquito Larvae Mortality. *Jurnal Ilmu Kesehatan Masyarakat*. 2020;9(01): 12–18. https://doi.org/10.33221/jikm.v9i01.820
21. Pawitri P, Achyani SZ. Effect of Noni Fruit Repellent (Morinda Citrifolia L.) on Aedes Aegypti Mosquito Hispanic Protection Power as a Biology Learning Resource for Senior High School Students. Edubiolock. 2019;1(1):37–49. http://scholar.ummetro.ac.id
22. Halimah H, Margi Suci D, Wijayanti I. Study of the Potential Use of Noni Leaves (Morinda citrifolia L.) as an Antibacterial Agent for Escherichia coli and Salmonella typhimurium. *Jurnal Ilmu Pertania Indonesia*. 2019;24(1):58–64. https://doi.org/10.18343/jipi.24.1.58
23. WHO. Guidelines For Efficacy Testing Of Mosquito Repellents For Human Skin. Who/Htm/Ntd/Whopes/2009.4. 2009. 1–6. https://www.who.int/publications/i/item/WHO-HTM-NTD-WHOPES-2009.4
24. Ihwah A, Deoranto P, Wijana S, Dewi IA. Comparative Study Between Federer and Gomez Method For Number of Replication in Complete Randomized Design Using Simulation: Study of Areca Palm (Areca catechu) As Organic Waste for Producing Handicraft Paper. *IOP Conference Series: Earth and Environmental Science*. 2018;131(1). https://iopscience.iop.org/article/10.1088/1755-1315/131/1/012049/pdf
25. Overview C. Chapter 2 Basic Tools of Analytical Chemistry. Analytical Chemistry 2.0. 2009. 1–28. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2012/07/Chapter211.pdf
26. Chowdhury S, Chakraborty P pratim. How To Choose And Interpret A Statistical Test? An Update For Budding Researchers. *Journal of Family and Medicine and Primary Care*. 2017;6(2):169–170. http://www.jfmpc.com/article.asp?issn=2249-4863;year=2017;volume=6;issue=1;spage=169;epage=170;aulast=Faizi
27. Colucci B, Müller P. Evaluation of Standard Field and Laboratory Methods To Compare Protection Times of The Topical Repellents PMD And DEET. *Scientific Reports*. 2018;8(1):1–11. https://www.nature.com/articles/s41598-018-30998-2
28. Khomsatun, Wahyudi, Hari Rudijanto I.W. G. Effectiveness of Betel Leaves Extract (Piper betle, Linn) as Mosquito Anopheles spp Repellent. *International Journal of Innovative Research in Science, Engineering and Technology*. 2019;8(5):5144–5152. https://doi.org/10.31983/jrk.v2i3.386
29. Asgarian TS, Moosa-Kazemi SH, Sedaghat MM. Impact of Meteorological Parameters on Mosquito Population Abundance And Distribution In A Former Malaria Endemic Area, Central Iran. *Heliyon*. 2021;7(12): e08477. https://doi.org/10.1016/j.heliyon.2021.e08477
30. Reinhold JM, Lazzari CR, Lahondère C. Effects Of The Environmental Temperature on Aedes aegypti and Aedes albopictus mosquitoes: A Review. *Insects*. 2018;9(4). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6316560/pdf/insects-09-00158.pdf
31. Wahyuni D, Sholikatin N. Repellent Effectiveness Test of Kaffir Lime Leaf Extract (Citrus Hystrix D.C) Against Aedes Aegypti Mosquito. *Jurnal Pharma Bhakta*. 2022;1(2):20–29. https://jurnalpharmabhakta.iik.ac.id/index.php/jpb/article/view/13/10

32. Lestari S, Septiyani BN, Proklamasiningsih E. Flavonoid Content and Antioxidant Activity of Kitolod (Hippobroma longiflora L.) at Different Altitude Sri. *LenteraBio: Berkala Ilmiah Biology*. 2024;13(2):212–218. https://journal.unesa.ac.id/index.php/lenterabio/article/view/23498/10940
33. Armayanti, Ashari R. Efficiency of Nori Leaf Extract Used As A Spray In The Control of Aedes Aegypti Mosquito. J*urnal Sulolipu: Media Komunikasi Sivitas Akademika dan Masyarakat*. 2019;19(2):157–161. https://journal.poltekkes-mks.ac.id/ojs2/index.php/Sulolipu/article/view/1349/881
34. Ullah A, Munir S, Badshah SL, Khan N, Ghani L, Poulson BG, et al. Important Flavonoids and Their Role as a Therapeutic Agent. *Molecules*. 2020;25:1–39. https://doi.org/10.3390/molecules25225243
35. Luqman BA, Yuliani D, Biologi J, Matematika F, Pengetahuan I, Universitas A, et al. The Effectiveness Extract of Noni Leaf (Morinda citrifolia L.) and Bintaro Leaf (Cerbera odollam) Against Mortality o. *LenteraBio: Berkala Ilmiah Biology*. 2023;12(2):179–185. https://journal.unesa.ac.id/index.php/lenterabio/index
36. Wheelwright M, Whittle CR, Riabinina O. Olfactory Systems Across Mosquito Species. *Cell and Tissue Research*. 2021;383(1):75–90. https://doi.org/10.1007/s00441-020-03407-2
37. Safitri IA, Cahyati WH. Effectiveness Of Zodia Leaves (Evodia Suaveolens) As Aedes Aegypti Mosquito Repellent. *Care Jurnal Ilmu-Ilmu Kesehatan*. 2018;6(1):1. https://core.ac.uk/download/pdf/229027773.pdf
38. Sudiarti M, Ahyanti M, Yushananta P, Tanjungkarang PK. Effectiveness Of Zodia Leaves (Evodia Suaveolens) As Aedes Aegypti Mosquito Repellent. *Ruwa Jurai: Jurnal Kesehatan Lingkungan*. 2021;15(1):8–15. https://core.ac.uk/download/pdf/229027773.pdf
39. Pandu ZA, Arif W, Teguh W. Effectiveness of Various Concentrations of Clover Leaf Extract (Syzygium Aromaticum, L.) As A Repellent Against the Rest of the Aedes Aegypti Mosquito. B*uletin Keslingmas: Buletin Kesehatan Lingkungan Masyarakat*. 2019;38(3):55–62. https://ejournal.poltekkes-smg.ac.id/ojs/index.php/keslingmas/article/view/5399/1413
40. Sari LR, Hestiningsih R. Repellent Efficacy of Kecombrang (Nicolaia Speciosa Horan) Extract Against Aedes Aegypti Linn Mosquitoes. *Jurnal Kesehatan Masyarakat*. 2016;3(3):754–763. https://ejournal3.undip.ac.id/index.php/jkm/article/view/12738
41. Nisa M, Irmayani I, Sarty SD. Development of Spray Gel Formulation for Ethanol Extract of Komba Komba Leaves (Eupatorim Odoratum) as Repellent Candidate. *JSFK (Jurnal Sains Farmasi & Klinis)*. 2022;20;5(1):41–45. https://openjournal.stifera.ac.id/index.php/jfsi/article/view/93

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Dietary Habit and Physical Activity as Risk Factors of Metabolic Syndrome among Civil Servants in Jambi City

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ABSTRACT
The prevalence of Metabolic Syndrome (MetS) is an important health problem due to the association with increased cardiovascular disease as the main cause of death. Approximately 20-25% of the global adult population including Indonesia suffers from MetS. The high prevalence is attributed to several factors namely lifestyle changes such as dietary habit and physical activity. Therefore, this study aimed to investigate the relationship between dietary habit and physical activity with MetS incidence among civil servant employees in Jambi City, Indonesia. A cross-sectional design was used to assess the proportion of MetS, dietary habit, and physical activity. A total of 108 civil servant employees were selected as respondents from six agencies using a multistage random sampling technique. Data collection was carried out through physical examination and interviews using a questionnaire. The results showed that the prevalence of MetS was 60.2%, with three risk indicators, namely central obesity (74.1%), blood pressure (66.7%), and HDL (63%). Based on the chi-square test, dietary habit (OR=2.571, 95%CI=1.151-5.744) and physical activity (OR=3.692, 95%CI=1.625-8.388) were significantly related to MetS. The persistently high prevalence of MetS was significantly related to dietary habit and physical activity among civil servant employees in Jambi City-Indonesia. These results underscored the need to improve understanding of healthy diets by adopting a balanced nutritional intake, increasing the intensity of physical activity according to age, and engaging in regular exercise.

INTRODUCTION

Indonesia is currently facing a double burden challenge due to changes in disease patterns, especially the increase in Non-Communicable Diseases (NCDs). In particular, cardiovascular diseases and diabetes mellitus pose the biggest challenge. NCDs account for approximately 41 million deaths every year in the world or 71% of all global mortality, with 77% occurring in lower-middle-income countries.[1] Meanwhile, Metabolic Syndrome (MetS) refers to the occurrence of cardiovascular disease and diabetes concomitantly with increasing risk components including hyperglycemia, raised blood pressure, hypertriglyceridemia, low high-density lipoprotein (HDL) cholesterol levels, and abdominal obesity. This condition is now recognized by the World Health Organization (WHO) as a disease.[2,3]

MetS is currently considered a pandemic because it attacks 20-30% of the global population.[4] The prevalence is approximately 15% in Europe, 14.2% in South Korea, and 36.9% in America,[3,5] while in Indonesia, it is estimated at 21.66%.[6,7] This condition poses twice the risk of developing cardiovascular disease and five times the risk of type 2 diabetes.[8–10] One of the high-risk population groups for MetS in Indonesia is civil servant employees.

Among all cities and districts in the Province, Jambi City has the highest prevalence of diabetes mellitus, namely 2.19% higher than the national prevalence. The prevalence of hypertension diagnosed by health workers in Jambi Province is 7.43%, while in Jambi City, it is 8.62%. Furthermore, the groups with the highest prevalence of risk factors for MetS are workers, civil servants, the Indonesian National Army/Republic of Indonesia Police, and employees of State-Owned Enterprises. The repetitive activity patterns, sedentary lifestyle, irregular eating patterns, consumption of high-calorie and fat diet, as well as irregular sleep patterns make this productive age group the most vulnerable.[6]

Kalsum, et al (2020) reported that the leading causes of death for lecturers at Jambi University included diabetes mellitus (with or without complications), heart attack, hypertension, liver cancer, and autoimmunity. These NCDs were closely related to the risk of an unhealthy diet and lifestyle. Male lecturers with a master's degree, who worked for a period of more than 30 years, as well as hailing from the faculty of social and humanities had a higher percentage of deaths.[11]

MetS is a set of risk factors directly related to the occurrence of arteriosclerotic cardiovascular disease and type 2 diabetes mellitus.[12,13] Although the pathophysiology is still controversial, the most widely recognized primary cause is insulin resistance, which correlates with central obesity. These two components influence the development of various other factors including triglycerides, glucose metabolism, elevated blood pressure, and vascular inflammation.[14] Although the criteria for MetS have not been standardized globally, the most commonly used include WHO, National Cholesterol Education Program-Adult Treatment Panel III (NCEP-ATP III), and International Diabetes Federation (IDF).[15–18]

Many factors influence the prevalence of MetS including dietary habit and physical activity.[19] Poor dietary habit without balanced energy secretion trigger obesity which is a risk component for MetS.[20] A “Western” diet with a high intake of whole grains and processed meats, fried foods, as well as red meat was associated with an increased prevalence of MetS, while adherence to a Mediterranean diet habit correlated with a lower prevalence. Furthermore, a correlation was established between Traditional Chinese dietary habit with weight loss and the prevalence of MetS.[21] Studies in Indonesia reported a prevalent risk attributed to high intakes of carbohydrates and fat.[17] Another study found a relationship between fast food consumption habits and MetS.[22] In general, physical activity plays an important role in the development of MetS, increasing energy requirement which affects weight loss, and triglyceride, and HDL cholesterol levels.[23] Currently, various conveniences have led to reduced physical activity, resulting in unbalanced calorie intake and use, which causes obesity. Several studies reported that physical activity was significantly related to the incidence of MetS.[12,24–26]

According to previous reports, dietary habit and physical activity have a significant influence on the prevalence of MetS. The national survey data in 2018, showed that Jambi City had the highest prevalence of cardiovascular diseases

and diabetes in the province.[6] Therefore, this study aimed to investigate the relationship between dietary habit and physical activity with the prevalence of MetS among public servant employees in Jambi City-Indonesia.

MATERIAL AND METHOD

A cross-sectional study was conducted in Jambi City, Indonesia from June to August 2022. A total of 108 respondents working as civil servant employees were selected from six government agencies through a multistage random sampling technique. Among the 30 offices, six clusters of Jambi city government offices were randomly selected as primary sampling units (PSU). These include Health Service, Education Service, Social Service, Government Office Jambi City Environment, Fire and Rescue Service, as well as Civil Service Police Unit. The number of samples (respondents) from the six government office clusters was calculated using a proportional sample size. Respondents from each cluster were selected at simple random according to the proportion of the predetermined sample size.

The inclusion criteria for the study respondents include those aged 20 years or above, who have fasted for at least 8 hours before blood sample examination and communicated well. Respondents who were pregnant or had a disease that could preclude participation such as cancer, and liver disease, or did not complete three visits during the study were excluded.

Data was collected using the physical examination results form for the five MetS criteria from NCEP ATP-III, namely abdominal circumference, blood pressure, glucose levels, triglycerides, and HDL cholesterol levels. This study used the NCEP-ATP III criteria to identify the five risk components of MetS with several cut points adapted from Alberti, et al. (2009) and Grundy, et al. (2016). These consisted of central obesity (abdominal circumference >90 cm for Asian men and >80 cm for women); hypertension (systolic >130 mmHg or diastolic >85 mmHg) or being treated for hypertension; hypertriglyceridemia (>150 mg/dL or 1.7 mmol/L) or being treated for hyper-triglyceridemia; low HDL (<40 mg/dL or 1.03 mmol/L in men) and (<50 mg/dL or 1.29 mmol/L in women) or on treatment for elevated HDL–C levels; and hyperglycemic (GDP > 100 mg/dL or 5.6 mmol/L) or have type 2 diabetes. A participant was declared to have MetS when three of the five risk components were met.[27,28]

Abdominal circumference was measured using a tape around the participant's abdomen standing straight with feet together and arms relaxed on either side. Measurement of blood pressure was carried out using digital sphygmomanometers on respondents in relaxed positions for at least two measurements. A third measurement of blood pressure was taken when the difference between the two readings for systolic blood pressure was more than 10 mmHg, or diastolic blood pressure was more than 5 mmHg.

The fasting glucose level was measured using the glucometer, while the measurement of HDL cholesterol and triglyceride levels was performed with a lipid profile device, according to standard guidelines. After physical examination, data was also collected through interviews with a questionnaire about respondents' dietary habit using the Food Frequency Questionnaire (FFQ) to obtain the frequency of food consumption in the last month classified into two categories namely "not good' and "good" based on the cut-off point (median) value. Physical activity status was determined using the validated Global Physical Activity Questionnaire (GPAQ) developed by WHO, consisting of 16 simple questions to estimate the level of physical activity during the past week using four domains. These include work, travel, recreational, and sedentary activities converted to Metabolic Equivalent Task minutes per week (MET) according to the GPAQ scoring protocol. Based on participant responses, the level of physical activity was classified into two categories namely low (total activity < 600 MET) and high (total activity ≥ 600 MET). A chi-square test was performed to analyze the relationship between dietary habit and physical activity with MetS. This study obtained ethical approval from the Research Ethics Commission Jambi Health Polytechnic with letter number: LB.02.06/2/649/2022.

RESULTS

This study acquired a response rate of 100%, and based on Table 1, the majority of respondents were 41-50 years old (41.70%),

male (54.60%), married (94.40%), had undergraduate education (50.00%), and earned family income of > Rp. 5 million to Rp. 10 million (50%) per month.

Table 2 shows the average results of MetS risk component measurement in the respondents including average abdominal circumference of 90.7 cm (SD = 12.14 cm), fasting blood glucose of 108 mg/dl (SD = 50.39 mg/dl), systolic blood pressure of 134.6 mmHg (SD= 18.65 mmHg), diastolic blood pressure of 88.7 mmHg (SD= 11.98 mmHg), triglyceride level of 151.2 mg/dl (SD= 84.45 mg/ dl), HDL level of 41.6 mg/dl (SD= 11.52 mg/dl).

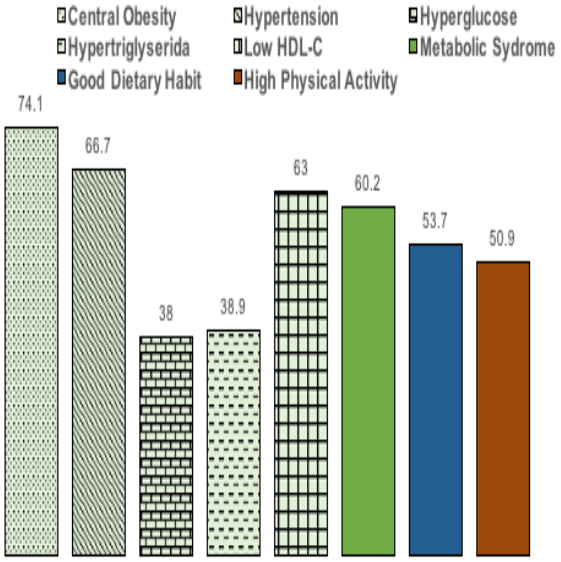
Figure 1 shows that the prevalence of MetS in the study population was 60.2%, with the three most common risk components being central obesity (74.1%), hypertension (66.7%), and low HDL cholesterol (63%). Moreover, the majority of respondents had good dietary habit (53,7%) and a high level of physical activity (50,9%). The average MET-minutes/week was 808.15 (SD= 600.7) with the lowest score being 60 and the highest being 2,760, while the estimated interval ranged from 693.5 to 922.7.

Table 3 shows the comparative association of dietary habit and physical activity with MetS. Based on the chi-square analysis results, there was a significant difference in the prevalence of MetS between respondents with not good and good dietary habit (p=0.033), as well as low and high physical activity (p=0.003).

Table 1. Characteristics of Respondents

Characteristics	n = 108	%
Age (Years) Mean = 46,2		
29-30	3	2.80
31-40	22	20.30
41-50	45	41.70
51-58	38	35.20
Sex		
Male	59	54.60
Female	49	45.40
Marital Status		
Not yet married	3	2.80
Married	102	94.40
Divorced	3	2.80
Education		
Senior High School	22	20.40
Undergraduate	54	50
Master/Doctoral	32	29.60
Income (Rp) Mean = Rp 8.278.004,-)		
2.000.000 – 5.000.000	34	31.50
> 5.000.000 – 10.000.000	54	50
> 10.000.000 – 20.000.000	18	16.70
> 20.000.000	2	1.80

Source: Primary Data, 2022



Source: Primary Data, 2022

Figure 1. Proportion of MetS Component, Dietary Habit, and Level of Physical Activity

Table 2. Measurement of MetS Risk Components

MS Criteria	Mean	SD	Min-Max	95% CI
Abdominal Circumference	90.7	12.14	60-132	88.4-93.0
Blood Glucose	108.1	50.39	69-399	98.5-118
Blood Pressure				
Systolic	134.6	18.65	88-179	131-138
Diastolic	86.4	11.98	59-114	84.1-88.7
Triglyceride	151.2	84.45	50-482	135-167.3
HDL-C	41.6	11.52	25-83	39.4-43.8

Source: Primary Data, 2022

Table 3. Association of Dietary Habit and Physical Activity with MetS

Variable	MetS		Non-MetS		*p-value*	OR	95% CI
	n	%	n	%			
Dietary Habit							
Not good	36	72	14	28	0.033	2.571	1.151– 5.744
Good	29	50	29	50			
Physical Activity							
Low	40	75.5	13	24.5	0.003	3.692	1.625– 8.388
High	25	45.5	30	54.5			

Source: Primary Data, 2022

DISCUSSION

Metabolic Syndrome (MetS) is a group of symptoms with the criteria of central obesity, hypertension, low High-Density Lipoprotein (HDL), high Fasting Blood Glucose (GDP), and High Triglyceride (TG) levels.[29] Affected individuals are characterized by twice the risk of death and three times the risk of having a heart attack or stroke compared to normal. Moreover, MetS has become a public health problem and clinical challenge globally. It is related to urbanization, excessive energy intake, increased incidence of obesity, and sedentary lifestyles as well as other associated impacts.[13,29]

Based on the results, the prevalence of MetS among civil servant employees in Jambi City was 60.2%. This value was unexpectedly higher than the range reported by several previous studies in Indonesia. According to Samodro, et al. (2020), the prevalence of MetS among 36 inpatients at Prof. Dr. Margono Soekarjo Hospital was 30%.[28] A study in Palangkaraya conducted on students reported that the proportion of respondents in the MetS risk category was 33.77%.[24] Another study by Listyandini, et al (2020) on workers at Tanjung Priok Port recorded a prevalence of 38.7%.[12] However, the results were in line with a study conducted in Surakarta districts, which reported a value of 64.7%.[27] A study carried out in the US on 12,047 adults found a MetS prevalence of 61.6%, 33.2%, and 8.6% in the obese, overweight, and normal weight groups.[18] Another investigation in Iran stated that the prevalence of MetS among respondents was 32.2%.[20] In Japan, residents of semi-mountainous areas were found to have a prevalence of 28.5%.[26] Meanwhile, in Malaysia, MetS had a prevalence of 32.2% among people aged 18 years and above. The condition was more common in Indians (51.9%), followed by Malays (36.7%) and Chinese (20.2%).[23]

The high prevalence of MetS in this study poses a clinical and public health challenge to prevent and control the risk factors, specifically central obesity, hypertension, and low HDL cholesterol. This is important considering that MetS has the potential to increase the risk of cardiovascular disease as the main cause of death in Indonesia.[7]

Based on the results, dietary habit was significantly related to the prevalence of MetS among civil servant employees in Jambi City (p= 0,033; OR= 2.571), suggesting poor dietary habit can increase the risk by 2.571 times. These results were consistent with several previous studies which also found a significant relationship between dietary habit and MetS. Godala, et al (2022) investigated the relationship between dietary behavior and MetS parameters. Among the three behavioral patterns identified, the strongest associations and the highest risk of MetS development were demonstrated in the Western-Sedentary group characterized by a high intake of fast-food products, white bread, red meat, and sweetened beverages.[19] A study by Samodro (2020) also reported a relationship between consumption patterns (fast food) with the incidence of MetS. Most food available in different regions often prioritizes delicious taste without considering the suitability of calorie and nutritional content.[28] However, other studies reported different results stating that dietary habit was not related to MetS. For example, Bil Khair and Harvianto (2021) proved that there was no significant relationship between diet and MetS among students.[24]

These results proved that diet was an important factor affecting nutritional condition and health status. Excessive food intake has been

associated with the incidence of MetS, particularly in terms of total calories, fat, and carbohydrates.[20] Specifically, excessive calories stimulate very low-density lipoproteins (VLDL) in the liver which causes hyper triglycerides, increased LDL, and decreased HDL levels.[22] The stimulation also leads to abdominal obesity due to the accumulation of visceral fat, elevated blood glucose levels (hyperglycemia), increased blood pressure (hypertension), and dyslipidemia caused by insulin resistance.[16] Dietary habit, such as rapid consumption of meals, frequent dining out, late eating, and skipping breakfast are reportedly associated with MetS according to studies in the East Asian region. For example, rapid consumption of meals is one of the risk factors for MetS among Koreans.[23]

Based on the results, there was a significant relationship between physical activity and MetS among civil servant employees in Jambi City (p= 0,003; OR= 3.692), suggesting that low physical activity increased the likelihood of developing MetS. Similarly, several previous studies have proven that physical activity was significantly related to the prevalence of MetS.[12] Godala, et al (2022) reported a relationship between low to moderate levels of physical activity with MetS.[19]

Regular physical activity can increase the expenditure of calories, thereby contributing to maintaining physical health, and reducing the risk of MetS.[24] Meanwhile, low physical activity causes the accumulation of excess calories and fatty acids, triggering the occurrence.[28]

CONCLUSION AND RECOMMENDATION

In conclusion, this study found a significant relationship between dietary habit and physical activity with the prevalence of MetS among civil servant employees in Jambi City. This suggests the need to improve understanding of healthy diet and physical activity to prevent MetS, by adopting a balanced nutritional diet, increasing the intensity of physical activity according to age, and engaging in regular exercise.

The chief of government institutions should adopt policies that allow staff to have sufficient time to move around at work, such as stretching exercises while working and joint healthy exercises. Staff are also recommended to transition from sugar, fat, and animal-based diets to more traditional plant-based diets, which can reduce health risks associated with MetS. Disseminating appropriate information about the dangers of a sedentary lifestyle through all available media is also crucial.

The health office can develop a health program policy in government institutions by establishing an Integrated Services Post (Posbindu) to provide regular health services and early detection of MetS risk factors for the prevention of PTM among civil servant employees. In addition, efforts should be made to provide health education to raise awareness in the prevention and control of MetS risk factors through the socialization of "CERDIK" behavior, namely regular health checks, cessation of cigarette smoking, frequent physical activity, healthy diet with balanced calories, sufficient rest, and stress management.

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AUTHOR CONTRIBUTIONS

G conceived and designed the experiments; ZN and PS performed the experiments; INI and G analyzed the data; All authors have read and approved the final manuscript. G = Guspianto; INI = Ismi Nurwaqiah Ibnu; ZN = Zafira Nadwa; PS = Puspita Sari.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

REFERENCES

1. WHO. Noncommunicable diseases: Key Facts. 2021.
2. Masriadi M, Gobel FA, Adam RK, Indrus H handayani. Determinants of Metabolic Syndrome (Hypertension and Diabetes Mellitus Type 2). In: Proceedings of the 3rd International Scientific Meeting on Public Health and Sports (ISMOPHS 2021). 2022. https://www.atlantis-press.com/proceedings/ismophs-21/125969334
3. Yang C, Jia X, Wang Y, Fan J, Zhao C, Yang Y, et al. Trends and Influence Factors in the

Prevalence, Intervention, and Control of Metabolic Syndrome Among US Adults, 1999–2018. *BMC Geriatrics*. 2022;22(1). https://link.springer.com/article/10.1186/s12877-022-03672-6?utm_source=getftr&utm_medium=getftr&utm_campaign=getftr_pilot

4. R. Lyons. Monograph on the Use of Herbs to Address Metabolic Syndrome. *Journal of Herbal Medicine*. 2024;43. https://doi.org/10.1016/j.hermed.2023.100840
5. Chae J, Seo MY, Kim SH, Park MJ. Trends and Risk Factors of Metabolic Syndrome Among Korean Adolescents, 2007 to 2018. *Diabetes & Metabolism Journal*. 2021;45(6):880–889. https://doi.org/10.4093/dmj.2020.0185
6. Kementerian Kesehatan RI. Laporan Riskesdas Propinsi Jambi 2018. Jakarta; 2019.
7. Herningtyas EH, Ng TS. Prevalence and Distribution of Metabolic Syndrome and Its Components among Provinces and Ethnic Groups in Indonesia. *BMC Public Health*. 2019;19(1). Available from: https://link.springer.com/article/10.1186/s12889-019-6711-7?utm_source=getftr&utm_medium=getftr&utm_campaign=getftr_pilot
8. Mohamed SM, Shalaby MA, El-Shiekh RA, El-Banna HA, Emam SR, Bakr AF. Metabolic Syndrome: Risk Factors, Diagnosis, Pathogenesis, and Management with Natural Approaches. *Food Chemistry Advances*. 2023;3. https://doi.org/10.1016/j.focha.2023.100335
9. Ananthy V, Priyadharsini RP, Subramanian U. Pathogenesis, Diagnosis, and Management of Metabolic Syndrome: A Comprehensive Review. *SBV Journal of Basic, Clinical and Applied Health Science*. 2021;4(2):39–45. https://jbcahs.sbvjournals.com/doi/pdf/10.5005/jp-journals-10082-03111
10. Nilsson PM, Tuomilehto J, Rydén L. The Metabolic Syndrome – What is it and How Should it be Managed?. *European Journal of Preventive Cardiology*. 2019;26:33–46. https://pubmed.ncbi.nlm.nih.gov/31766917/
11. Kalsum U, Nasution HS, Ibnu IN. Individual Characteristic and the Causes of Death in Lecturers at Jambi, Indonesia. In: *Proceedings of the 3rd Green Development International Conference (GDIC 2020)*. 2021. https://www.atlantis-press.com/proceedings/gdic-20/125960286
12. Listyandini R, Dewi Pertiwi F, Puspa Riana D, Studi Kesehatan Masyarakat Fakultas Ilmu Kesehatan Universitas Ibn Khaldun Bogor P, Kesehatan Pelabuhan Kelas Tanjung Priok Jakarta KI. Asupan Makan, Stress, dan Aktivitas Fisik dengan Sindrom Metabolik pada Pekerja di Jakarta. *Jurnal Kajian dan Pengembangan Kesehatan Masyarakat*. 2020;1(1):19–23. https://jurnal.umj.ac.id/index.php/AN-NUR
13. Lokpo SY, Norgbey AN, Osei-Yeboah J, Owiredu WK, Annani-Akollor ME, Orish VN, et al. Predictors of Metabolic Syndrome and Its Components in Patients with Type 2 Diabetes: A Cross-Sectional Study in the Ho municipality, Ghana. *Scientific African*. 2024;23. https://doi.org/10.1016/j.sciaf.2023.e02016
14. Fahed G, Aoun L, Zerdan MB, Allam S, Zerdan MB, Bouferraa Y, et al. Metabolic Syndrome: Updates on Pathophysiology and Management in 2021. *International Journal of Molecular Sciences*. 2022;23. https://pubmed.ncbi.nlm.nih.gov/35054972/
15. Dobrowolski P, Prejbisz A, Kurylowicz A, Baska A, Burchardt P, Chlebus K, et al. Metabolic Syndrome a New Definition and Management Guidelines. *Archives of Medical Science*. 2022;18(5). https://www.archivesofmedicalscience.com/pdf-152921-78084?filename=Metabolic%20syndrome%20_%20a.pdf
16. Khamroevna Razhabova G, Dzhumaev KS. Metabolic Syndrome: Methods of Prevention and Treatment. *Novateur*

Publications International Journal of Innovations in Engineering Research And Technology [IJIERT]. 2020;7(6):148–153. https://media.neliti.com/media/publications/337249-metabolic-syndrome-methods-of-prevention-fe324815.pdf

17. Murningtyas FS, Larasati MD, Rahmawati AY, Prihatin S. Besar Risiko Faktor Fisiologis Dan Faktor Perilaku Terhadap Kejadian Sindrom Metabolik. *Jurnal Riset Gizi*. 2020;8(1):11–17. https://ejournal.poltekkes-smg.ac.id/ojs/index.php/jrg/article/view/5152
18. Shi TH, Wang B, Natarajan S. The Influence of Metabolic Syndrome in Predicting Mortality Risk among US Adults: Importance of Metabolic Syndrome Even in Adults with Normal Weight. Preventing Chronic Disease. 2020;17. https://pubmed.ncbi.nlm.nih.gov/32441641/
19. Godala M, Krzyżak M, Maślach D, Gaszyńska E. Relationship between Dietary Behaviors and Physical Activity and the Components of Metabolic Syndrome: A Case-Control Study. *International Journal of Environmental Research and Public Health*. 2022;19(11). https://pubmed.ncbi.nlm.nih.gov/35682146/
20. Lorzadeh E, Sangsefidi ZS, Mirzaei M, Hosseinzadeh M. Dietary Habits and Their Association with Metabolic Syndrome in A Sample of Iranian Adults: A Population-Based Study. *Food Science & Nutrition*. 2020;8(11). https://pubmed.ncbi.nlm.nih.gov/33282272/
21. Park SI, Suh J, Lee HS, Song K, Choi Y, Oh JS, et al. Ten-Year Trends of Metabolic Syndrome Prevalence and Nutrient Intake Among Korean Children and Adolescents: A Population-Based Study. *Yonsei Medical Journal*. 2021;62(4). https://doi.org/10.3349/ymj.2021.62.4.344
22. Nurzakiah, Hadju V, Jafar N, Indriasari R, Sirajuddin S, Amiruddin R. Literature Review: Pengaruh Pola Makan Terhadap Sindrom Metabolik. *Jurnal Kajian dan Pengembangan Kesehatan Masyarakat*. 2021;1(2). https://jurnal.umj.ac.id/index.php/ANNUR/article/view/8638
23. Iqbal SP, Ramadas A, Fatt QK, Shin HL, Onn WY, Kadir KA. Relationship of Sociodemographic and Lifestyle Factors and Diet Habits with Metabolic Syndrome (Mets) Among Three Ethnic Groups of the Malaysian Population. *PLoS One*. 2020;15(3). https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0224054
24. Bil Khair F, Harvianto Y, Studi PJKR P, Palangka Raya U. Hubungan Aktivitas Fisik Dan Pola Makan Pada Sindrom Metabolik Mahasiswa. *Jurnal Keolahragaan JUARA*. 2021;1(2):64–69. https://e-journal.upr.ac.id/index.php/juara/article/download/3847/2900
25. Asrizal CW, Farrastama MD. Hubungan Tingkat Pengetahuan dan Tingkat Aktivitas Fisik Sebagai Pencegah Sindrom Metabolik. *Jurnal Kedokteran Syiah Kuala*. 2021;21(2). https://jurnal.usk.ac.id/JKS/article/view/20566/14636
26. Kudo N, Nishide R, Mizutani M, Ogawa S, Tanimura S. Association Between the Type of Physical Activity and Metabolic Syndrome In Middle-Aged and Older Adult Residents of A Semi-Mountainous Area In Japan. *Environmental Health and Preventive Medicine*. 2021;26(1). https://link.springer.com/article/10.1186/s12199-021-00949-x?utm_source=getftr&utm_medium=getftr&utm_campaign=getftr_pilot
27. Puryaningtyas RD, Sarbini D. Hubungan Asupan Karbohidrat dan Protein dengan Kejadian Metabolic Syndrome pada Pekerja Wanita di PT. Iskandar Indah Printing Textile Surakarta. *Prosiding The 12th University Research Colloqium 2020 Universitas Aisyiyah Surakarta*. 2020;178. http://repository.urecol.org/index.php/proceeding/article/view/1139
28. Samodro P, Prastowo A, Zulfannisa NH, Wahyuni N. Konsumsi Fast Food dan Aktivitas Fisik dengan Kejadian Sindrom

Metabolik Di RSUD Prof. Dr. Margono Soekarjo Purwokerto. J*URNAL NUTRISIA*. 2020;21(2):83–90. https://www.nutrisiajournal.com/index.php/JNUTRI/article/view/187/70

29. Tylutka A, Morawin B, Walas Ł, Michałek M, Gwara A, Zembron-Lacny A. Assessment of Metabolic Syndrome Predictors in Relation to Inflammation and Visceral Fat Tissue in Older Adults. *Scientific Reports*. 2023;13(1). https://www.nature.com/articles/s41598-022-27269-6

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Hand Hygiene Practices among Nurses in South Sulawesi Hospitals

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ABSTRACT
Healthcare professionals' adherence to hand hygiene protocols is paramount to prevent Healthcare-Associated Infections (HAIs) and ensure patient safety. This study evaluates compliance with the World Health Organization's (WHO) "Five-Moment Hand Hygiene" protocol among nurses in two Indonesian hospitals: Regional General Hospital X in Makassar City and Provincial General Hospital Y in South Sulawesi Province. A total of 60 nurses participated, with demographic analysis revealing significant differences between the hospitals. Utilizing a comprehensive observation tool provided by the WHO, data analysis indicated variations in hand hygiene practices, particularly after touching patient surroundings. Despite these differences, the data followed a normal distribution, enhancing the reliability of statistical analyses. Significant disparities in hand hygiene practices were found after touching patient surroundings (*p-value* = 0.008; $\alpha < 0.05$), underscoring the urgent need for targeted interventions among nurses to improve their compliance and enhance patient safety. This study recommends comprehensive training, resource provision, regular audits, fostering a supportive organizational culture, and integrating robust hand hygiene modules into nursing education. The study also suggests further research to identify barriers and improvement strategies. Addressing these recommendations collectively will bolster patient safety and reduce healthcare-associated infection burdens in Indonesian healthcare settings. The study's identification of specific deficiencies in hand hygiene practices provides actionable insights for healthcare administrators, infection control practitioners, and frontline healthcare workers, emphasizing the urgency of sustained efforts to promote proper hand hygiene practices.

INTRODUCTION

This study emphasizes the critical need for robust support mechanisms to ensure compliance with World Health Organization (WHO) guidelines, particularly regarding hand hygiene facilities and staff education within hospital settings. Inadequate implementation of hygienic practices has profound implications, as it can lead to an increased risk of procedure or Healthcare-Associated Infections (HAIs), resulting in unnecessary suffering and preventable fatalities. Moreover, insufficient hygienic and secure healthcare practices within hospital settings can have far-reaching consequences, providing broader implications for both the healthcare system and society. For example, these infections not only strain healthcare resources but also impose significant financial burdens on patients and their families.[1]

Furthermore, HAIs can prolong hospital stays, induce long-term disabilities, and contribute to the emergence of antimicrobial resistance, which complicates treatment options and threatens public health on a global scale. Thus, addressing the gaps in implementing hygienic practices is not only essential for patient safety but also critical for ensuring the sustainability and effectiveness of healthcare systems worldwide.[2]

The global impact of HAIs (also known as nosocomial infections), highlighted by the WHO, is alarming, with certain infections causing 1.4 million daily deaths worldwide. Notably, in Europe and the United States alone, nosocomial infections account for tens of thousands of fatalities annually, emphasizing the urgent need for effective management strategies across all healthcare facilities.[3]

Data from reputable sources like the Centers for Disease Control and Prevention (CDC) reveal concerning trends, such as a substantial increase in surveillance of Hospital-Acquired Dermatitis (IAD) and Urinary Tract Infections (UTI) over recent years.[4]

Scholars believe the effectiveness of preventive measures, including hand hygiene protocols, depends on their comprehensive implementation across all hospital units. When conducted comprehensively, these measures not only emphasize the importance of environmental hygiene but also play a crucial role in combating antimicrobial resistance.[5]

To address these challenges, various programs are initiated, ranging from occupational health to infection identification and management, adopting an epidemiological perspective to break the chain of infection. [6] One practical example of such a program is the Infection Prevention and Control (IPC) program.

In Indonesia, adherence to healthcare standards, particularly concerning HAIs, is regulated by the Ministry of Health. Failure to meet these standards can have severe consequences, including the revocation of operating permits for hospitals with high incidences of nosocomial infections. Despite regulatory efforts, current data from hospitals like Robert Wolter Mongisidi Regional Hospital consistently exceed established targets, indicating persistent challenges in infection control.[7]

In hospital practice, hand hygiene should follow specific guidelines, such as the Five Moments for Hand Hygiene, outlined by the WHO. These moments include those before touching a patient, before cleaning/aseptic procedures, after body fluid exposure risk, after touching a patient, and after touching a patient surrounding. To adhere to these guidelines, healthcare workers should follow specific steps for hand hygiene.[8]

The steps involve wetting hands with water, applying enough soap to cover all hand surfaces, rubbing hands palm to palm to create lather, rubbing the palms together with fingers interlocked, rubbing the backs of fingers against the opposing palm with fingers interlocked, rubbing the left thumb rotationally clasped in the right palm, and vice versa, rubbing rotational rubbing of the right palm over the back of the left hand with fingers interlaced, and vice versa, rinsing hands thoroughly with water, drying hands thoroughly with a single-use towel or air dryer, and using the towel to turn off the faucet and disposing of it properly.

As argued earlier, effective implementation of hand hygiene protocols at these key moments is essential for preventing HAIs and reducing the risk of antimicrobial resistance. By adhering to these guidelines, hospitals can enhance patient safety and contribute to overall infection control efforts.

Among health professionals in the hospital role, nurses are prone to acquiring infections

and transmitting infectious agents. Thus, they play a significant role in healthcare settings. Furthermore, the comparison between nurses in provincial and city hospitals is essential. This comparative analysis is motivated by the recognition that regional disparities may influence outcomes. As such, variations in adherence to protocols and patient safety standards may emerge due to contextual differences between these settings.[9]

In light of these considerations, this study aims to evaluate the adherence to the "Five Moments for Hand Hygiene" protocol among nurses in two hospital environments: Regional General Hospital X in Makassar City and Provincial General Hospital Y in South Sulawesi Province. Through a comparative analysis of compliance levels between these hospitals, the research seeks to pinpoint specific areas requiring improvement. Ultimately, the goal is to provide insights to enhance patient safety and infection control measures across healthcare settings. Additionally, in the context of Indonesia, nurses play a crucial role in precisely arranging patient care, which directly impacts patient safety.[10]

MATERIAL AND METHOD

This research utilized a comparative descriptive approach. It observed and assessed hand hygiene practices within hospital environments, particularly focusing on infection control units where adherence to hand hygiene protocols was closely monitored. One rationale for researching hand hygiene among nurses in regional and city hospitals is the potential variation in adherence to hand hygiene protocols between different healthcare settings.

Provincial hospitals may face different challenges and resource constraints compared to city hospitals, which could impact the implementation of hand hygiene practices. Understanding these variations is crucial for developing targeted interventions to improve compliance and enhance patient safety across all healthcare facilities. Additionally, comparing hand hygiene practices between provincial and city hospitals can provide valuable insights into the effectiveness of existing protocols and identify areas for improvement in infection control measures. Overall, conducting such research can contribute to standardizing hand hygiene practices and reducing the risk of healthcare-associated infections in diverse healthcare settings.

The sample size for this study was determined using Jacob Cohen's method to ensure statistical validity and reliability. A minimum sample size was calculated based on established parameters to achieve sufficient statistical power. Consequently, 30 nurses were selected from each hospital, resulting in a total sample size of 60 nurses across the two hospitals under investigation.

This methodological approach adheres to best practices in research methodology, enabling researchers to draw meaningful conclusions from the data collected. By adhering to established standards for sample size determination, the study aims to enhance the robustness of its findings and ensure the validity of its conclusions.

Furthermore, involving 30 nurses from each hospital facilitates a comprehensive examination of hand hygiene practices within distinct healthcare settings. This approach not only enables comparative analyses between hospitals but also allows researchers to identify potential variations or discrepancies regarding hand hygiene protocols.

In summary, using Jacob Cohen's method for sample size determination emphasized this study's rigorous and methodical approach. By ensuring a sufficient sample size, the research aimed to generate reliable insights into hand hygiene practices among nurses, contributing to the advancement of knowledge in infection control and patient safety within healthcare environments.

In this study, meticulous attention was given to the selection process and utilization of the observation tool provided by the WHO. The tool was specifically tailored to capture the critical moments of hand hygiene. It was well structured to encompass the five crucial moments for hand hygiene, as outlined in the WHO guidelines. These moments included hand hygiene before patient contact, before aseptic procedures, after body fluid exposure risk, after patient contact, and after contact with patient surroundings.

The observation tool was designed precisely to generate accurate and detailed data

collection. Each critical moment was clearly delineated within the tool, accompanied by specific criteria for compliance. This ensures that observers can effectively assess nurses' adherence to hand hygiene protocols across all critical moments.

Moreover, the observation tool incorporates a standardized scoring system to quantify nurses' compliance with hand hygiene practices. This scoring system enables observers to objectively evaluate how nurses adhere to each critical moment, allowing for consistent and reliable data collection.

To enhance the reliability of the collected data, each nurse's adherence to hand hygiene practices was observed multiple times throughout the observation period. This repeated observation approach ensures that data are robust and representative of nurses' typical hand hygiene behaviours.

Furthermore, the observation tool was accompanied by detailed instructions and guidelines for observers to ensure consistency and accuracy in data collection. Prior to the study, observers underwent comprehensive training to familiarize themselves with the tool and its application, minimizing the risk of observer bias and enhancing the reliability of the collected data. The meticulous selection and utilization of the WHO-provided observation tool indicate the study's commitment to rigorous methodology. It also commits to generating high-quality data on hand hygiene practices among nurses.

Another critical step in this study was assessing the tool's validity. This step ensures the validity and accuracy of the study's findings. This process involves scrutinizing the *r*-table values assigned to each component of the tool. In this context, the obtained *r*-table values were 0.815, 0.633, 0.681, 0.815, and 0.681. All surpassed the established critical *r*-table threshold of 0.632.

Such an outcome indicates that the tool exhibits a commendable level of validity across its various components, as it consistently aligns with recognized standards. Subsequently, attention was turned towards the *kappa* value derived from the observation sheet utilized in the study, which yielded a value of 0.615. This metric serves as a crucial indicator of agreement among enumerators tasked with completing the five-moment hand hygiene observation sheet.

The calculated *kappa* value suggests a substantial concordance among observers, signifying a robust and reliable agreement in their assessments of hand hygiene practices. The combined findings from the validity test and *kappa* analysis serve to bolster the credibility and reliability of the tool employed in this research. These tests ensure the tool's efficacy in accurately capturing and measuring the intended constructs related to hand hygiene practices. Such validation enhances the overall trustworthiness of the study's findings and conclusions, ensuring their relevance and applicability within the broader context of healthcare research.

Furthermore, it is worth noting that data in this study was meticulously analyzed using Microsoft Excel® software version 2019 for data collection and SPSS® Statistics version 26 for statistical analysis. Categorical variables were methodically presented as frequency and percentage and analyzed using the Chi-square test. Meanwhile, continuous variables, a normal distribution, were expressed as mean and standard deviation, with statistical analysis conducted using paired *t*-tests and *z*-tests. The determination of statistical significance was set at $p < 0.05$, thus ensuring the rigor and validity of the study's findings.

Since this study involved human subjects, ethical approval for the research was required, and it was obtained from the Research Ethics Committee of the Faculty of Medicine, Hasanuddin University, with approval number 147/UN4.6.4.5.31/PP36/2022. Throughout the research process, stringent ethical principles were upheld to ensure a scientific approach and to prevent harm to research subjects. Measures were implemented to safeguard participant confidentiality and integrity, from proposal development and data collection to the dissemination of results.

RESULTS

This research involved 60 nurses as respondents who were divided into 30 nurses in each hospital. The mean of their ages was 33.27±4.727 at Regional General Hospital X Makassar City and 35.10±6.536 at Provincial General Hospital Y South Sulawesi Province. In terms of gender, 4 male respondents and 26 female respondents were from Regional General Hospital X Makassar City. Meanwhile, 2 male and 28 female respondents were from Provincial General Hospital Y South Sulawesi Province. They have the same demographic pattern for the category gender.

The last category was education, where 13 participants at Regional General Hospital X Makassar City held a diploma level, and 17 completed an undergraduate degree. Meanwhile, 12 respondents at Provincial General Hospital Y, South Sulawesi Province, had a diploma level, whereas 18 had an undergraduate level. Table 1 describes the demographics of respondents in both hospitals, with a *p*-value of 0.000, underscores the substantial differences observed between the two groups. This significant disparity may stem from various factors, such as demographic characteristics, geographic location, or institutional differences.

The results of the overall implementation of nurses in carrying out the "Five Moments for Hand Hygiene" protocol are presented in Table 2. The table reveals that the highest adherence among nurses was in the first moment. In this study, the majority of nurses in both hospitals consistently washed their hands before attending to (touching) patients, with 96.7% at the Regional General Hospital X and 93.3% at the Provincial General Hospital Y. In contrast, the lowest adherence was found in the third moment, which was the implementation of hand hygiene immediately after exposure to body fluids, with only a minority (3.3%) of nurses adhering to this moment at each hospital.

Further analysis of the data reveals that the majority of respondents prioritize hand hygiene before attending to (touching) patients, followed by hand hygiene after touching the patient's environment. Notably, Table 2 provides a significant difference in the proportion of nurses who wash their hands after touching the patient's environment (20%) between the two hospitals. This difference may stem from variations in hospital policies, resource availability, or the level of emphasis placed on hand hygiene education and training in each institution.

Table 1. Demographic Features in Both Groups

Characteristics	General Hospital X Makassar City (n = 30)			General Hospital Y South Sulawesi Province (n = 30)			*p*-value
	n (%)	Mean ± SD	Min-Max	n (%)	Mean ± SD	Min-Max	
Age	30 (50)	33.27±4.727	27-42	30 (50)	35.10 ± 6.536	26-48	0.654*
Gender							
Males	4(13.30)	-	-	2(6.70)	-	-	0.000
Females	26(86.70)			28(93.30)			
Education							
Diploma	13(43.30)	-	-	12(40)	-	-	0.125**
Bachelor	17(56.70)			18(60)			

* : Paired *t*-test

** : Chi-square

Source: Primary Data, 2022

Table 2. Five Moments for Hand Hygiene Actions in Both Groups, Proportional Difference

Variables	General Hospital X Makassar City (n = 30)	General Hospital Y South Sulawesi Province (n = 30)	Difference	*p*-value
	n (%)	n (%)		
Before Touching A Patient				
Performed	27(90)	28(93.30)	3.3%	0.008
Missed Actions	3(10)	2(6.70)		
Before Cleaning/ Aseptic Procedure				
Performed	5(16.7)	3(10)	6.7%	0.492
Missed Actions	25(83.3)	27(90)		
After Body Fluid Exposure Risk				
Performed	1(3.30)	1(3.30)	0	0.317
Missed Actions	29(96.70)	29(96.70)		
After Touching A Patient				
Performed	5(16.70)	5(16.70)	0	0.165
Missed Actions	25(83.30)	25(83.30)		
After Touching the Patient's Surrounding				
Performed	6(80)	12(60)	20%	0.008**
Missed Actions	24(20)	18(40)		

**Significant differences, Mann-Whitney Test α=0.05
Source: Primary Data, 2022

The Mann-Whitney test results confirm this disparity, with a statistically significant difference (*p*-value = 0.008; $\alpha < 0.05$), highlighting variations in hand hygiene practices across hospitals at this specific moment. Consequently, the statistical tests employed, including the Mann-Whitney test, are deemed appropriate and offer valuable insights into the discrepancies observed in hand hygiene practices between the two hospitals.

Conversely, no significant difference was found in the proportion of nurses who washed their hands at the other three critical moments (before cleaning aseptic procedure to after touching a patient) across the two hospitals. This suggests a consistent adherence to hand hygiene protocols in these aspects among nurses in both hospital settings.

Overall, the findings highlight areas for improvement in hand hygiene practices, particularly in adhering to specific moments outlined in the "Five Moments for Hand Hygiene" protocol. These results underline the importance of targeted interventions to enhance compliance and ensure uniform adherence to hand hygiene standards across healthcare settings.

DISCUSSION

The observed compliance levels were classified as either high or low adherence. In this study, indicating a need to enhance the nursing staff's adherence to hand hygiene protocols during patient care. Suboptimal hand hygiene practices pose a potential risk of HAIs or nosocomial infections, emphasizing the importance of addressing factors influencing compliance.

The WHO recommends a comprehensive strategy to improve compliance with hand hygiene protocols among healthcare workers.[11] This strategy encompasses five key elements: system change, training and education, monitoring and feedback, workplace reminders/communication, and climate change/safety culture.[12]

The present research, based on WHO guidelines concerning the Five Moments for Hand Hygiene, revealed a concerning trend. Despite established protocols, many nurses still lacked compliance in their implementation. This finding is in line with another study that similarly highlights the persistent issue of non-compliance among nursing staff. In fact, implementing the WHO guidelines can signifi-

cantly reduce the incidence of infections associated with poor hand hygiene practices.[13] Various studies support WHO's multimodal improvement strategies, highlighting the effectiveness of each component in enhancing hand hygiene compliance.[14]

For instance, systemic changes within the healthcare system are proven to create an environment conducive to compliance.[15] Meanwhile, education and training programs equip healthcare professionals, especially nurses, with the necessary knowledge and skills.[16] Following that, regular monitoring, a key aspect of the strategy, ensures continuous evaluation and feedback, emphasizing the importance of maintaining compliance. Therefore, considering the unique situation in Indonesia, discussing the prevalence of hand hygiene compliance in this country is crucial.[17]

A nuanced perspective is provided by focusing on the unique challenges faced by Indonesian health facilities, particularly Makassar City Regional General Hospital and South Sulawesi Regional General Hospital. Investigating factors contributing to nonadherence, such as inadequate support facilities like the availability of alcohol-based hand sanitizers in inpatient units, highlights the need for targeted interventions.[18]

In our study, we have identified significant disparities in compliance rates across the five aspects of hand hygiene, highlighting the critical need for tailored interventions. For example, while we found that compliance before patient contact generally meets expectations, there were notable gaps in other crucial moments, particularly before aseptic procedures. These deficiencies directly threaten patient safety, heightening the risk of HAIs due to inadequate hand hygiene practices.[19]

Our research specifically underscores the heightened risk associated with the lack of proper hand hygiene practices before aseptic procedures, emphasizing the urgent necessity to improve compliance in this area.[20,21] By addressing these deficiencies, we not only protect the health of healthcare workers but also enhance patient safety by mitigating the transmission of infectious agents.[22, 23]

In contrast, the forthcoming article by Smith et al. is anticipated to offer a broader perspective on hand hygiene compliance trends and intervention effectiveness across diverse healthcare settings. Leveraging meta-analytical data, their systematic review is poised to quantify the impact of WHO-recommended strategies on hand hygiene compliance rates, providing comprehensive insights into influencing factors and potential solutions.[24]

Our research's focus on identifying specific deficiencies in hand hygiene practices and their implications for patient safety complements the systematic review's broader scope. By shedding light on observed compliance differences and their consequences for patient care, our study enriches understanding of localized challenges and emphasizes the crucial role of targeted interventions in improving hand hygiene practices among healthcare workers.

In conclusion, our study underscores the importance of customized interventions to address localized hand hygiene compliance issues. While we contribute valuable insights in this regard, the forthcoming systematic review by Smith et al. is expected to provide evidence-based recommendations for enhancing compliance across varied healthcare settings. A comparative analysis of both studies' findings promises to deepen our understanding of effective strategies for mitigating the risk of HAIs and improving patient outcomes in Indonesian healthcare settings.[25]

CONCLUSION AND RECOMMENDATION

The research compared the implementation of the "Five Moments for Hand Hygiene" protocol by nurses at Regional General Hospital X in Makassar City and Provincial General Hospital Y in South Sulawesi Province. The results reveal a concerning trend: adherence to the WHO guidelines falls below standard. This finding highlights the critical importance of proper hand hygiene practices in healthcare settings, emphasizing the urgent need for improvement initiatives to bolster patient safety and curb healthcare-associated infections.

Stakeholders, including healthcare administrators, infection control practitioners, nursing leaders, and frontline healthcare workers, stand to benefit from the insights provided by this research. These insights enable them to allocate resources, tailor interventions, and foster a culture of excellence in hand hygiene practices.

Furthermore, among the five aspects of hand hygiene moments, only two moments (before touching a patient and after touching the patient's surroundings) exhibit the most significant adherence to hand hygiene between these two hospitals. To address these findings, hospitals and healthcare institutions should prioritize initiatives aimed at enhancing hand hygiene compliance among nursing staff.

This entails implementing comprehensive training programs, ensuring accessibility to hand hygiene resources, conducting regular audits, and cultivating a supportive organizational culture. Additionally, there is an urgent need for nursing education programs to integrate robust training modules on hand hygiene, empowering nurses with the knowledge and resources needed for consistent adherence to evidence-based guidelines.

Moreover, further research is suggested to delve into barriers to compliance and identify strategies for sustaining improvements in hand hygiene practices. This will collectively contribute to bolstering patient safety and mitigating the burden of healthcare-associated infections.

AUTHOR CONTRIBUTIONS

All listed authors have contributed to this work. MRA conceptualized the study, designed the methodology, conducted research, analyzed data, drafted the manuscript, and obtained funding. RR, AS, and GM helped analyze and provide input regarding the flow and methods needed. They also helped assess the quality of the article's writing. All authors approved the final version of the manuscript for submission. MRA = Muhammad Rizky Asfarada; RR = Rini Rachmawaty; AS = Andina Setyawati; GM = Gulzar Malik.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Smith SR, Hagger MS, Keech JJ, Moyers SA, Hamilton K. Improving Hand Hygiene Behavior Using a Novel Theory-Based Intervention During the COVID-19 Pandemic. *Annals of Behavioral Medicine*. 2022;56(11):1157–73. https://doi.org/10.1093/abm/kaac041
2. Tacconelli E. Linking Infection Control to Clinical Management of Infections to Overcome Antimicrobial Resistance. *Journal of Hospital Infection*. 2021;114:1–9. https://doi.org/10.1016/j.jhin.2021.04.030
3. Haque M, McKimm J, Sartelli M, Dhingra S, Labricciosa FM, Islam S, et al. Strategies to Prevent Healthcare-Associated Infections: A Narrative Overview. *Risk Management and Healthcare Policy*. 2020;13:1765–1780. https://www.tandfonline.com/doi/epdf/10.2147/RMHP.S269315?needAccess=true
4. Voidazan S, Albu S, Toth R, Grigorescu B, Rachita A, Moldovan I. Healthcare Associated Infections—A New Pathology in Medical Practice?. *International Journal of Environmental Research and Public Health*. 2020;17(3):760. https://doi.org/10.3390/ijerph17030760
5. Amaan A, Dey SK, Zahan K. Improvement of Hand Hygiene Practices among the Healthcare Workers in A Neonatal Intensive Care Unit. *Canadian Journal of Infectious Diseases and Medical Microbiology*. 2022;2022:1–7. https://doi.org/10.1155/2022/7688778
6. Hillier MD. Using Effective Hand Hygiene Practice to Prevent and Control Infection. *Nursing Standard*. 2020;35(5):45–50. https://doi.org/10.7748/ns.2020.e11552
7. Riu SDM, Talibo NAT. Perilaku dan Ketersediaan Fasilitas Rumah Sakit dengan Kepatuhan Perawat Melakukan Hand Hygiene. *Jurnal Keperawatan Stikes Kendal*. 2021;13(1). https://doi.org/10.32583/keperawatan.v13i1.1074
8. Smith F, Lee K, Binnie-McLeod E, Higgins M, Irvine E, Henderson A, et al. Identifying the World Health Organization's Fifth Moment for Hand Hygiene: Infection Prevention in the Operating Room. *Journal of Infection Prevention.* 2020;21(1):28–34. https://doi.org/10.1177/1757177419879996
9. Memon R, Asif M, Khoso AB, Tofique S, Kiran T, Chaudhry N, et al. Recognising Values and Engaging Communities Across Cultures:

Towards Developing a Cultural Protocol for Researchers. *BMC Med Ethics*. 2021;22(1):47. https://doi.org/10.1186/s12910-021-00608-4

10. CDC. Healthcare-Associated Infections (HAI) Progress Report. Atlanta: Centers for Disease Control and Prevention; 2020. https://arpsp.cdc.gov/profile/national-progress/united-states?HAI-SELECT-SIR=haiVAE&HOSPITAL-SELECT-SIR=haiHospital109
11. Harun MGD, Anwar MMU, Sumon SA, Mohona TM, Hassan MZ, Rahman A, et al. Hand Hygiene Compliance and Associated Factors Among Healthcare Workers in Selected Tertiary-care Hospitals in Bangladesh. *Journal of Hospital Infection*. 2023;139:220–227. https://doi.org/10.1016/j.jhin.2023.07.012
12. Bisbey TM, Kilcullen MP, Thomas EJ, Ottosen MJ, Tsao K, Salas E. Safety Culture: An Integration of Existing Models and a Framework for Understanding Its Development. *Human Factors: The Journal of the Human Factors and Ergonomics Society*. 2021;63(1):88–110. https://doi.org/10.1177/0018720819868878
13. Roshan R, Feroz AS, Rafique Z, Virani N. Rigorous Hand Hygiene Practices Among Health Care Workers Reduce Hospital-Associated Infections During the COVID-19 Pandemic. *Journal of Primary Care & Community Health*. 2020;11. https://doi.org/10.1177/2150132720943331
14. Nuckchady DC. Impact of a Multimodal Improvement Strategy to Promote Hand Hygiene at a Hospital in Mauritius. *Cureus*. 2021; 13(6): e15812. https://doi.org/10.7759%2Fcureus.15812
15. Byrne AL, Baldwin A, Harvey C. Whose Centre is it anyway? Defining Person-centred Care in Nursing: An Integrative Review. *PLoS One*. 2020;15(3):1-12. https://doi.org/10.1371/journal.pone.0229923
16. Mlambo M, Silén C, McGrath C. Lifelong Learning and Nurses' Continuing Professional Development, a Metasynthesis of the Literature. *BMC Nursing*. 2021;20(62):1-13. https://doi.org/10.1186/s12912-021-00579-2
17. Loftus MJ, Guitart C, Tartari E, Stewardson AJ, Amer F, Bellissimo-Rodrigues F, et al. Hand Hygiene in Low- and Middle-income Countries. *International Journal of Infectious Diseases*. 2019;86:25–30. https://doi.org/10.1016/j.ijid.2019.06.002
18. Tantum LK, Gilstad JR, Horng LM, Tandanpolie AF, Styczynski AR, Letizia AG, et al. Feasibility and Acceptability of A Novel Intervention to Improve Hand Hygiene Behavior in Rural Liberian Health Facilities. *Journal of Water, Sanitation and Hygiene for Development*. 2023;13(6):403–414. https://doi.org/10.2166/washdev.2023.190
19. Martos-Cabrera MB, Mota-Romero E, Martos-García R, Gómez-Urquiza JL, Suleiman-Martos N, Albendín-García L, et al. Hand Hygiene Teaching Strategies among Nursing Staff: A Systematic Review. *International Journal of Environmental Research and Public Health*. 2019;16(17):1-13. https://doi.org/10.3390/ijerph16173039
20. Ben Fredj S, Ben Cheikh A, Bhiri S, Ghali H, Khefacha S, Dhidah L, et al. Multimodal Intervention Program to Improve Hand Hygiene Compliance: Effectiveness and Challenges. *Journal of the Egyptian Public Health Association*. 2020;95(1):1-8. https://doi.org/10.1186/s42506-020-00039-w
21. Akuchie C, Deng F, McCormick W, Moore J, Shaw Z, Lonks JR. Practical Considerations in Hospital Infection Prevention. *Journal of Brown Hospital Medicine*. 2023;2(4). https://doi.org/10.56305/001c.87912
22. Kuipers SJ, Cramm JM, Nieboer AP. The Importance of Patient-centered Care and Co-creation of Care for Satisfaction with Care and Physical and Social Well-being of

Patients with Multi-morbidity in the Primary Care Setting. *BMC Health Service Research*. 2019;19(13):1-9. https://doi.org/10.1186/s12913-018-3818-y

23. Magadze TA, Nkhwashu TE, Moloko SM, Chetty D. The Impediments of Implementing Infection Prevention Control in Public Hospitals: Nurses' perspectives. *Health SA Gesondheid*. 2022;27:1-8. https://doi.org/10.4102%2Fhsag.v27i0.2033
24. Soboksa NE, Negassa B, Kanno G, Ashuro Z, Gudeta D. Hand Hygiene Compliance and Associated Factors among Healthcare Workers in Ethiopia: A Systematic Review and Meta-Analysis. *Advances in Preventive Medicine*. 2021;2021:1–10. https://doi.org/10.1155/2021/7235248
25. Smith S, Johnson G. A Systematic Review of the Barriers, Enablers and Strategies to Embedding Translational Research within the Public Hospital System Focusing on Nursing and Allied Health Professions. *PLoS One*. 2023;18(2):1-22. https://doi.org/10.1371/journal.pone.0281819

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Relationship Between Medication Adherence and Blood Sugar Levels Among Diabetes Mellitus Outpatients

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ABSTRACT
Diabetes Mellitus (DM) is a disease with progressively increasing prevalence every year and often leads to complications when not properly managed. Control or success of treatment is influenced by adherence of patients to the treatment process. This study aimed to analyze relationship between medication adherence and fasting glucose levels among DM outpatients. A correlation study was conducted using a cross-sectional approach on a sample of 300 respondents selected by probability sampling technique from the entire population. The instrument used was the MMAS-8 Test (Morisky Scale Medication Adherence Scales-8) and examination of fasting sugar levels. Meanwhile, data analysis was conducted with the Spearman Rho test. The results showed that the highest treatment adherence was in the moderate category by 130 (43.3%) and a decrease in fasting sugar levels was observed among 230 (76.7%) respondents. A significant relationship was found between medication adherence and fasting glucose levels with a p-value = <0.001 and r: -0.597. Based on the results, there was a negative relationship between medication adherence and fasting blood sugar. The higher medication adherence, the better the fasting sugar levels in DM outpatients.

INTRODUCTION

The global population suffering from Diabetes Mellitus (DM) in 2030 is expected to reach approximately 366 million in Indonesia according to the World Health Organization (WHO). Moreover, the International Diabetes Federation (IDF) estimated that the prevalence of DM will increase with the rising age of the population affecting 19.9% or 111.2 million among people aged 65-79 years. The prevalence is expected to reach 578 million in 2030 and 700 million in 2045.[1]

DM is a type of non-communicable disease with a progressively increasing prevalence every year. This disease is better known as a silent killer because it is not often noticed by sufferers until complications arise.[1] DM has the highest prevalence at the age of 55 to 64 years and tends to be higher in women.[2] Indonesia is ranked the seventh country with the most DM sufferers in the world after China, India, America, Brazil, Russia, and Mexico.[1] Furthermore, DM is the third most common cause of death accounting for 6.7% mortality below stroke (21.1%) and coronary heart disease (12.9%). At the regional level, Central Java ranks eleventh among cities with a 2.1% prevalence of DM.[1] Based on the 2018 Riskesdas results, the prevalence in Boyolali Regency is 2.2% with an estimated sufferers of 18,325 in 2021.[3]

As a metabolic disease, DM is characterized by hyperglycemia or an increase in blood sugar above normal, glucose secretion in the urine due to lack of insulin secretion, decreased insulin action, or both. Type II DM is caused by a lack of insulin production by pancreatic beta cells or the inability of the body to optimize use.[4] Insulin is a hormone that functions to control blood sugar balance. DM management demands considerable time and patience due to the chronic nature, requiring medical support and family assistance.

One of the risks of DM is an unhealthy lifestyle, in this context, lifestyle describes the pattern of behavior in the patient's daily life that influences physical condition. This includes diet, weight control, sleep habits, and regular exercise. Lifestyle can be used as a window into the personality of each individual, with a healthy lifestyle mitigating an increase in DM.[5]

The World Health Organization (WHO) defines adherence to long-term medication as "the extent to which a person taking medication, following a diet, or making lifestyle changes, conforms to agreed recommendations from health care providers".[6] Compliance stems from the basic word 'obedient' which means complying with an order given by someone.[7,8] Strict adherence to taking medication prevents chronic DM disease,[9,10] while non-adherence is currently an important problem. Factors contributing to medication adherence include gender, level of knowledge, number of drugs taken in a day, family support, and support from health workers.[11] Low levels of education and knowledge are related to low adherence, including daily health status.[12] Another factor is controlling body weight through diet.

Adherence to long-term therapy for chronic diseases in developed countries averages 50%.[13] Health workers must also monitor patients to ensure an appropriate level of adherence with medication which correlates with fasting blood sugar. The monitoring must be carried out repeatedly or periodically.[14]

In Indonesia, adherence to taking medication varies among DM patients, with the low-level category being more dominant.[15] Several studies have found that patients with controlled blood sugar tend to have good medication adherence,[5,16] contributing to the quality of life.[17]

PKU Aisyiyah Hospital of Boyolali is a trusted healthcare facility for the examination and treatment of DM patients. As a private hospital competing with state facilities, the right strategy is needed in providing services to gain customer trust and satisfaction. Based on data from the Medical Records in 2021, the total number of DM patients who visited every month for treatment was estimated at 300 (PKU Aisyiyah Boyolali Hospital Medical Records data, 2021). The patients also required proper management to prevent further non-communicable diseases such as heart, stroke, kidney failure, and others.

The success of treating non-communicable diseases is not only influenced by the quality of health services, and support from the family, but also by patient adherence. This factor plays a crucial role in the failure to control blood glucose in DM patients. The PKU Aisyiyah Hospital has not yet reached the target for DM control, showing the need for efforts to monitor glycemic control.[16] Medical personnel have been given special assignments to provide education

related to treatment, specifically for new DM patients and treatment education to enhance adherence.[17]

This study aimed to analyze relationship between medication adherence and fasting sugar in DM outpatients. The results will be used as a portrait of the performance of health workers, specifically in relation to service and developing follow-up plans for both families and patients.

MATERIAL AND METHOD

This correlation study was conducted with a cross-sectional approach at the PKU Aisyiyah Boyolali Hospital Outpatient Center from June to September 2021. The population comprised type II DM patients who were allowed to go home after receiving education about medications. Nurses also checked compliance with treatment and medication as well as fasting blood sugar during one month of control in April 2021. The sample included 300 patients selected using probability sampling, with data retrieved from the Medical Records.

The inclusion criteria were 1) type II DM patients with fasting blood sugar ≥ 126 mg/dl in outpatient room, and 2) received oral drug therapy. On the other hand, the exclusion criteria included 1) patients not fasting at the time of checking the fasting blood sugar, and 2) not present for control in the following month.

The instrument used for medication adherence measurement was MMAS-8 (Morisky Scale Medication Adherence Scales-8) consisting of eight questions with firm answer types of "Yes" and "No" in the form of closed-ended questions. Another instrument was the examination of fasting blood sugar levels in the Hospital Laboratory. MMAS-8 has been tested for validity and reliability in many cases, including a study in 2016 that measured adherence to anti-cholesterol medication.[18] The results showed moderate internal consistency (Cronbach's α=0.759) with good test-retest reliability (Spearman coefficient=0.860). Another study in 2021 measured adherence with chronic pain treatment and found that the Cronbach's α coefficient was 0.625, suggesting the internal consistency was relatively satisfactory. The Pearson correlation coefficient was 0.845 (p<0.001), showing high convergent validity.[19]

The MMAS-8 instrument was used when patients visited for control one month later, with the assistance of family who ensured all question items were answered. Fasting blood sugar checks were carried out by hospital laboratory staff.

The analysis used the Spearman Rho Test statistical correlation test at a significant 5%. Ethical approval was received from the ethical committee with number: 135/LPPM/ITS.PKU/IX/2021 dated 24 September 2021.

RESULTS

The distribution of characteristics includes age, gender, occupational status, and education. Table 1 showed that the highest age range was 56-65 years with 110 (36.70%) respondents, followed by > 65 years, 46-55 years, and 36-45 years with 90 (30%), 80 (26.70%) and 20 (6.70%) respondents respectively. The majority were women with 180 (60%), while men were only 120 (40%). The most predominant occupation was housewives with 120 (40%) respondents, followed by private sector, teachers, civil servants, retirees, and farmers with 50 (16.70%), 40 (13.30%), 40 (13.30%), 40 (13.30%) and 10 (3.30%) respectively. The highest level of education was Elementary School with 90 (30%) respondents, followed by Senior High School with 80 (26.70%), University with 80 (26.70%), and Junior High School with 50 (16.70%) respondents.

Table 1. Characteristics of Respondents

Characteristics	n= 300	%
Age (Year)		
36-45	20	6.70
46-55	80	26.70
56-65	110	36.70
> 65	90	30
Sex		
Male	120	40
Female	180	60
Occupational Status		
Work	140	46.70
Not Work	160	53.30
Education		
Elementary School	90	30,00
Junior High School	50	16.70
Senior High School	80	26.70
University	80	26.70

Source: Primary Data, 2021

Treatment adherence distribution obtained using the Morisky Medication Adherence Scale (MMAS-8) is shown in Table 2. Based on the results, the highest distribution was in the middle category with 130 (43.30%) respondents followed by the high category with 120 (40%).

The fasting blood sugar examinations were conducted and the results were classified as increase or decrease. Subsequently, statistical data on fasting blood sugar levels were obtained (Table 3). Based on Table 3, the majority of the respondents namely 230 (76.70%) had increased blood sugar levels.

Considering that normal distribution requirements were not met, the test used was the Spearman rho correlation. Table 4 shows the correlation coefficient value of r= -0.597 in the category of quite strong relationship with a p-value of <0.001. Strong treatment adherence will effectively reduce blood sugar levels.

DISCUSSION

Medication adherence is important for type II DM patients to achieve treatment goals and effectively prevent complications.[20] A high level of adherence can reduce and maintain normal blood sugar levels in the body, accelerating healing. On the other hand, low adherence leads to poor control of blood glucose levels.[16] The greater the adherence of patients to taking anti-diabetic medication, the lower the blood sugar levels in line with the normal limits, and vice versa.[20]

Table 2. Distribution of Treatment Adherence

Treatment Adherence	n = 300	%
High	120	40
Middle	130	43.30
Low	50	16.70

Source: Primary Data, 2021

Table 3. Distribution of Blood Sugar Levels Month 1 and 2

Blood Sugar Levels	n = 300	%	Mean (Min-Max)	Std. Deviasi
Increase	70	23.30	1,8 (1-2)	0,4
Decrease	230	76.70		

Source: Primary Data, 2021

Table 4. Association between Treatment Adherence and Blood Sugar Levels

	Blood Sugar Levels
Treatment Adherence	r = - 0.597 *p-value* = < 0.001 n = 300

Source: Primary Data, 2021

Adherence of patients to treatment was influenced by several factors, namely gender, therapeutic regimen, and interaction with health workers or family. Patient factors include the limitations of the body function and socioeconomic aspects while the therapeutic regimen factor refers to the number of drugs received. To enhance compliance, interventions should address the factors, with health education or counseling being key strategies. These efforts can increase knowledge, understanding, awareness, and sufficient adherence to medication.[21] Education, accompaniment, observation, counseling, and reminders about DM care have been shown to increase medication adherence.[22]

Education has an important role because diabetic patients who receive Diabetes Self Management Education (DSME) can experience improvements in metabolic control, quality of life, and a decrease in complications. DSME reportedly has a positive effect in increasing self-confidence and change in self-management behavior of type II DM patients.[6] The achievement of medication adherence is not only limited to education by medical personnel but also influenced by family support.[7]

The results support many previous studies including Ashenafi et al., (2022) where medication adherence was low and significantly associated with poor glycemic control. Several medical conditions and medications were found to be associated with adherence, as shown by p: 0002.[23] The results offer insights into how to overcome the existing program at PKU Aisyiyah Singkil Boyolali Hospital. In this context, there is a need to improve the quality of education for DM outpatients through repeated counseling during visits.[20]

Health promotion is needed for patients enter-

ing the medical rehabilitation stage after treatment with DM. Theme structure, methods, family participation, knowledge of patients, and other factors must be conveyed to hospital management. High treatment compliance will also help improve quality of life, as reported by Perwitasari (2016) stating that the quality of hospital services including counseling, education, as well as gender and age contributed significantly to influencing treatment compliance and the quality of life.[24]

CONCLUSION AND RECOMMENDATION

In conclusion, this study found that the majority of DM outpatients had moderate adherence with decreased fasting sugar levels. The results showed a significant relationship between medication adherence and fasting sugar levels. However, this study was limited by the method of filling the MMAS-8 instrument, which is not yet commonly used at PKU Aisyiyah Singkil Boyolali Hospital. Consequently, families or patients had to fill the instrument in a makeshift place leading to discomfort. Future studies should focus on the establishment of MMAS-8 in the standard operational procedure for the care of DM patients.

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AUTHOR CONTRIBUTIONS

Data collection and conceptulaization: IU, SU. Study design: IU, MH. Data collection: IU, SU. Writing and submitting manuscript: IU. Writing: AY, YK, LA, UBR, SSTH, and DNU. Editing and approval of final draft: IU, MH. The authors read and approved the final manuscript. IU = Ida Untari; SU = Sri Utami; MH = Muhammad Hafiduddin; AY = Asmirati Yakob; YK = Yuli Kusumawati; LA = Lina Alfiyani; UBR = Umi Budi Rahayu; SSTH = Sri Sat Titi Hamranani; DNU = Devid Noor Umam.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest associated with the material presented in this paper.

REFERENCES

1. Kementerian Kesehatan RI. Infodatin Tetap Produktif, Cegah, dan Atasi Diabetes Melitus 2020. Jakarta: Pusat Data dan Informasi Kementerian Kesehatan RI. 2020: 1–10. https://pusdatin.kemkes.go.id/resources/download/pusdatin/infodatin/Infodatin-2020-Diabetes-Melitus.pdf
2. Kemenkes RI. Hasil Riset Kesehatan Dasar Tahun 2018. Jakarta: Kementerian Kesehatan RI. 2018.
3. Dinkes. Profil Kesehatan Kabupaten Boyolali. Boyolali: Dinas Kesehatan Kabupaten Boyolali. 2021. https://dinkes.boyolali.go.id
4. Boulton A. IDF Diabetes Atlas. 10TH ed. Vol. 102, Diabetes Research and Clinical Practice. International Diabetes Federation; 2021. 1–135 p.
5. Aminde LN, Tindong M, Ngwasiri CA, Aminde JA, Njim T, Fondong AA, et al. Adherence to Antidiabetic Medication and Factors Associated with Non-Adherence among Patients with Type-2 Diabetes Mellitus in Two Regional Hospitals in Cameroon. *BMC Endocrine Disorder*. 2019;19(1):1–9. https://doi.org/10.1186/s12902-019-0360-9
6. Alqarni AM, Alrahbeni T, Al Qarni A, Al Qarni HM. Adherence to Diabetes Medication Among Diabetic Patients in The Bisha Governorate of Saudi Arabia – A Cross-Sectional Survey. *Patient Prefer Adherence*. 2019;13:63–71. https://doi.org/10.2147%2FPPA.S176355
7. Diantari IAPM, Sutarga IM. Kepatuhan Minum Obat Pada Pasien Diabetes Melitus Tipe 2 di Wilayah Kerja Puskesmas Tabanan Ii Tahun 2019. *Archive of Community Health*. 2019;6(2):40. https://doi.org/10.24843/ACH.2019.v06.i02.p04
8. Lestarina NNW. Theory of Planned Behavior sebagai Upaya Peningkatan Kepatuhan pada Klien Diabetes Melitus. *Media Kesehatan Masyarakat Indonesia*.

2018;14(2):201-207. https://doi.org/10.30597/mkmi.v14i2.3987

9. Piragine E, Petri D, Martelli A, Calderone V, Lucenteforte E. Adherence to Oral Antidiabetic Drugs in Patients with Type 2 Diabetes: Systematic Review and Meta-Analysis. *Journal of Clinical Medicine*. 2023;12(5). https://doi.org/10.3390/jcm12051981
10. Mora Romo JF. Adherencia al Tratamiento en Personas Con Diabetes Mellitus Tipo 2 En México. *Psicumex*. 2022;12:1–20. https://doi.org/10.36793/psicumex.v12i1.493
11. Anggraini DE, Rahayu SR. Gejala Klinis Tuberkulosis pada Keluarga Penderita Tuberkulosis BTA Positif. *Higeia Journal of Public Health*. 2018;1:91-101. https://journal.unnes.ac.id/sju/index.php/higeia/article/view/18100
12. Sahoo J, Mohanty S, Kundu A, Epari V. Medication Adherence Among Patients of Type II Diabetes Mellitus and Its Associated Risk Factors: A Cross-Sectional Study in a Tertiary Care Hospital of Eastern India. *Cureus*. 2022;14(12):6–14. https://doi.org/10.7759/cureus.33074
13. Tsehay T, Engidawork E, Ahmed A. Assessment of Antidiabetic Medication Adherence and Its Determinants among Ambulatory Patients with Type 2 Diabetes. *Journal of Pharmacy and Alternative Medicine*. 2016;11:19–24. https://www.researchgate.net/publication/318340413_Assessment_of_Antidiabetic_Medication_Adherence_and_Its_Determinants_among_Ambulatory_Patients_with_Type_2_Diabetes_at_Tikur_Anbessa_Specialized_Hospital_Addis_Ababa_Ethiopia
14. Sidiq R, Amos J, Widdefrita W, Novelasari N, Silaban EM, Yannurdin Y, et al. The Needs for Information and Education Media in Supporting Self-Management of Patients with Diabetes Mellitus. *Media Kesehatan Masyarakat Indonesia*. 2020;16(2):247. https://doi.org/10.30597/mkmi.v16i2.9774
15. Pertiwi MV, Alfian R, Nita Y, Athiyah U. Medication Adherence of Diabetes Mellitus Patients in Indonesia: A Systematic Review. *Pharmacy Education*. 2022;22(2):188–193. https://doi.org/10.46542/pe.2022.222.188193
16. Wahiduddin. Kendali Glikemik pada Pasien Diabetes Melitus Tipe 2. *Media Kesehatan Masyarakat Indonesia*. 2019;15(1):99. https://doi.org/10.30597/mkmi.v15i1.5292
17. Chantzaras A, Yfantopoulos J. Association between Medication Adherence and Health-Related Quality of Life of Patients with Diabetes. *Hormones*. 2022;21(4):691–705. https://doi.org/10.1007/s42000-022-00400-y.
18. Vika V, Siagian M, Wangge G. Validity and reliability of Morisky Medication Adherence Scale 8 Bahasa version to Measure Statin Adherence among Military Pilots. *Health Science Journal of Indonesia*. 2016;7(2):129–133. https://doi.org/10.22435/hsji.v7i2.5343.129-133
19. Zhang Y, Wang R, Chen Q, Dong S, Guo X, Feng Z, et al. Reliability and Validity of a Modified 8-Item Morisky Medication Adherence Scale in Patients With Chronic Pain. *Annals Palliative Medicine*. 2021;10(8):9088–9095. https://doi.org/10.21037/apm-21-1878
20. Sembiring E. Medication Adherence Improvement of Patients with Type 2 Diabetes Mellitus. *International Journal of Nursing and Health Services (IJHNS).* 2021;4(3):258–265. https://ijnhs.net/index.php/ijnhs/article/view/430
21. Letassy N. Medication Taking. The *Science of Diabetes Self-Management and Care*. 2007;33(6):1030. https://doi.org/10.1177/0145721707308477
22. Triyanto E, Isworo A, Rahayu E. Model Pemberdayaan Terpadu untuk Meningkatkan Kepatuhan Pasien Diabetes Mellitus.

Media Kesehatan Masyarakat Indonesia. 2015;1(1):228–234. https://journal.unhas.ac.id/index.php/mkmi/article/view/528

23. Sendekie AK, Netere AK, Kasahun AE, Belachew EA. Medication Adherence and Its Impact on Glycemic Control in Type 2 Diabetes Mellitus Patients with Comorbidity: A Multicenter Cross-Sectional Study in Northwest Ethiopia. *PLoS One*. 2022;17:1–18. https://doi.org/10.1371/journal.pone.0274971
24. Perwitasari DA, Urbayatun S. Treatment Adherence and Quality of Life in Diabetes Mellitus Patients in Indonesia. *SAGE Open*. 2016;6(2). https://doi.org/10.1371/journal.pone.0274971